interactIVe

Accident avoidance by active intervention for Intelligent Vehicles

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SEVENTH FRAMEWORK PROGRAMME

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Summary

interactIVe has the objective to develop new integrated Advanced Driver Assistance Systems (ADAS). If these systems should be introduced to the market, the legal barriers and obligations need to be considered. Therefore, a subproject called “Evaluation and Legal Aspects” is part of interactIVe, with the main objective to provide an evaluation framework for the interactIVe systems as well as to investigate the legal framework for the systems.

This document outlines the legal framework with regard to the developed interactIVe functions. It is divided into three main parts: first, the interactive functions are described. Second, vehicle type-approval for interactive functions according to relevant UN ECE[1] regulations is analyzed, and third, the legal framework on EU-level is investigated.

Vehicle type-approval is limited mainly by steering and braking regulations. While the brake system regulation allows new technical approaches, if the functions and underlying functional safety concepts are declared to the issuer of a type-approval certificate, the steering regulation is stricter with the interactive functions.

That regulation allows automatic steering only in a speed range up to 10 (+2) km/h (which is only enough for automatic parking systems) and above this speed permits only steering actions to maintain the basic desired course of the driver (for a limited time duration) or to stabilize the vehicle.

In this context, safe cruise, lane change collision avoidance and rear-end collision avoidance cannot be type-approved according to current UN ECE regulations due to their steering intervention. The treatment of the collision mitigation system is not clear. All these issues should be addressed by future adaption and clarification of regulation 79.

The functions developed in the interactIVe-project are affected by the legal framework on EU-level mainly with regard to product liability and to international law (Vienna Convention on Road Traffic). Functions providing for mere information / warnings can easily be overridden and hence be controlled by the driver. Functions providing for automated braking and/or steering interventions bring along an increase of the product liability risk. From a product liability point of view it is recommendable to design a function in a way which allows the driver to override automated braking and/or steering interventions. Product liability risks have to be addressed appropriately, also with regard to the Vienna Convention on Road Traffic which constitutes the requirement of controllability.

[1] United Nations Economic Commission for Europe

1 Introduction

Legal barriers and obligations are an important constraint in the regular development process of vehicle functions. However interactIVe's intention is to take a broader look on what functions could be possible without these "obstacles".

While this is done, interactIVe needs to provide a view on the consequences for vehicle type-approval and the legal framework. The intended purpose is to investigate if certain regulations might hinder the introduction of new technologies and applications such as the functions developed within the interactIVe project.

This deliverable provides the analysis of interactIVe functions regarding conformity with a) current vehicle type-approval regulations and b) the current legal framework on EU-level.

The goal of this deliverable is to outline the changes in regulations and legal framework that would be necessary, if the interactIVe functions go into production.

In the first part a short summary of the interactIVe functions is given.

The second part first summarizes the constraints derived from relevant regulations. The second part gives a detailed analysis of each interactIVe function and closes with a summary.

The following third part concentrates on an analysis identifying the relevant legal framework on EU-level, i.e. the respective International Law and EU Directives. After a first general overview concerning the different fields of law – particularly International Road Traffic Law and Product Liability Law – possibly affected by the functions developed within the project, the third part provides for an evaluation of the individual functions in detail.

2 Description of the interactIVe functions

In this chapter the different interactIVe functions are presented. The function description is the initial point for the legal aspect analysis of the functions. This chapter is structured with regard to the three vertical subprojects (SECONDS, INCA and EMIC). For each vertical subproject the different functions are described separately.

The functions' descriptions base upon the information given in the interactIVe deliverables D1.5[2] and D1.6[3] and describe the current status at the time the deliverable is being written. Therefore the final version of the functions can differ from the described functions' version described in this deliverable.

The developed functions will be integrated in the seven demonstrator vehicles. An overview on the functions and the demonstrator vehicles, in which the functions are integrated, is given in the table below:

interactIVe functions	Demonstrator vehicle						
	BMW	CRF	CONTI	FFA	VCC	VTEC	VW
SECONDS							
Continuous Support		X		X	X		
Curve Speed Control				X			
enhanced Dynamic Pass Predictor	X						
Safe Cruise					X		
INCA							
Lane Change Collision Avoidance				X	X		
Oncoming Vehicle Collision Avoidance/Mitigation						X	
Rear End Collision Avoidance				X		X	
Side Impact Avoidance				X		X	
Run-off Road Prevention				X	X	X	
EMIC							
Collision Mitigation System							X
Emergency Steer Assist			X				

Table 2.1: interactIVe demonstrator vehicles and functions

2.1 SECONDS

First the functions of the vertical subproject "SECONDS" are described. The subproject "SECONDS" includes the following four functions:

[2] Mäkinen, T. / Alessandretti G./ Kanstrup, L. / et al., interactIVe deliverable D1.5, p.75 et seq.

[3] Lytrivis, P. / Bolovinou, A. / Kotsiourou, C. / et al., interactIVe deliverable D1.6, p.24 et seq.

- Continuous Support [CS]
- Enhanced Dynamic Pass Predictor [eDPP]
- Curve Speed Control [CSC]
- Safe Cruise [SC]

The SECONDS functions should support the driver continuously through the driving process in order to avoid dangerous situation in advance. Besides they should also support the driver in critical situations.

2.1.1 Continuous Support

The Continuous Support (CS) function supports the driver continuously while driving by means of different HMI channels in order to prevent the driver from running into dangerous situations. Further the function assists the driver in dangerous situations. The support consists of information and warnings. Depending on the demonstrator vehicle, in which the function is installed, the function can also intervene in the driving behaviour of the vehicle.

In order to support the driver through the driving process the function continuously evaluates the status of the host vehicle as well as of the surrounding traffic. Therefore the function uses data of the different on-board sensors (radar, LIDAR, camera and ultrasonic sensors) and the digital map. Vehicle-to-Infrastructure (V2I) communication can also be used as an option delivering more information e.g. on crossing vehicles. The function will be able to work also without the information of the V2I-communication. Based on the sensors' information the hazard potential of the situation is calculated. This is the basis for the decision, whether a warning is issued or the function intervenes.

Besides safety aspects the function should also consider fuel efficiency aspects. Therefore some demonstrator vehicle will be equipped with an active accelerator pedal that gives the driver a haptic feedback, if the driver does not drive ecologically.

The reaction of the CS function is common for all use cases. After the CS function has detected the dangerous situation, it issues a warning to the driver. By means of the warning the driver's attention should be redirected to the situation in order to give the driver the possibility to react to the hazard. The warning can increase continuously depending on the situation and the degree of hazard. For the warnings given by the CS function mainly haptic warnings are used combined with visual warnings. The detailed warning strategy will be developed in collaboration SP3 'IWI Strategies - Information, Warning & Intervention Strategies'.

If the driver does not react to the imminent hazard, the function will also - depending on the demonstrator vehicle - intervene in the dynamic behaviour of the vehicle. In case of a collision during lane change and drift out of lane the function would act on the vehicle's course. For the longitudinal use cases (rear end collision, collision with crossing traffic, unsafe speed and traffic rule violations) the function will react by decelerating the vehicle. Therefore the CS function uses a steering actuator and a braking actuator

The steering actuators, which are used by the function, will apply a maximum steering torque of 3 Nm respectively 4 Nm. Such a steering torque is comparable to the steering torque, which is applied by systems, which already have been introduced to the market[4,5]. Hence it can be assumed that the driver is able to override this steering torque.

[4] Schmidt, Haptische Signale in der Lenkung: Controllability zusätzlicher Lenkmomente, p.15

[5] N.N., New Lancia Delta: Italian bourgeoisie with great ambitions, http://www.autopressnews.com/2008/06/Lancia/Lancia_Delta.shtml

In one demonstrator the function can also take over partly the vehicle control (longitudinal: by means of ACC stop/go and lateral by mean of lane keeping system) similar to the Safe Cruise function.

2.1.2 Curve Speed Control

The Curve Speed Control (CSC) function informs or warns the driver when he/she is approaching a curve with an unsafe speed. The approaching of curve with a too high speed increases the risk of losing control or to collide with oncoming vehicle in the adjacent lane.

In order to calculate the safe speed for a next curve it is necessary to measure the current position of vehicle and of the next curve. The safe speed is calculated by means of the digital map data and the information provided by the onboard camera sensor. Further information from the infrastructure could be used additionally for the calculation of a safe speed.

Based on this information it is determined, whether the CSC has to warn the driver or intervene. Therefore determined safe speed for a curve is compared to the driven speed. The HMI devices or the longitudinal actuator are activated depending on this result.

After the function has detected the excessive speed for the upcoming curve, the function issues a warning first. The warning can be a visual, audio and haptic warning. The final warning and intervention strategy will be defined to a later stage in collaboration with SP3.

If the adaptive cruise control (ACC) is active, the CSC function will also autonomously adjust the set speed of the ACC. The set speed will set to the safe speed for the upcoming curve before entering the curve in order to reduce the vehicle velocity. By the adjustment of the set speed the function can actuate the braking system indirectly. There will be no intervention, if the ACC is switched off. Due to the fact that the ACC is overrideable the CSC function will also be overrideable by the driver.

2.1.3 enhanced Dynamic Pass Predictor

The enhanced Dynamic Pass Predictor (eDPP) function determines whether the driver of the host vehicle wants to overtake another vehicle and whether the available overtaking path is sufficient for the planned overtaking manoeuvre. Therefore the function calculates the needed overtaking path by considering the following parameters:

- Allowed driving speed along the most-probable-path (including legal speed limits, maximum curve speed and crossings)
- Frontal visibility based on road geometry
- Distance, speed and acceleration of vehicle-to-be-overtaken
- Length of the vehicle-to-be-overtaken
- Distance, speed, acceleration, length of vehicles in front of target vehicle
- Ego vehicle acceleration characteristics
- V2X communication
- Probability of opposite traffic
- Driver-specific parameters

The calculated overtaking path is compared to the available overtaking path in front of the vehicle, which is determined based on the information of the different onboard sensors (radar sensors and camera sensor) and the digital map. Furthermore, Vehicle-to-Vehicle (V2V) and V2I communication will be also used to detect upcoming vehicles or limitation of the overtaking path (e.g. road works or upcoming curve). If the available overtaking path is shorter than the calculated overtaking path, the function will inform or warn the driver depending on the situation. By means of this warning it should be possible for the driver to

react early enough to prevent an imminent accident with the oncoming vehicle, e.g. by aborting the overtaking manoeuvre.

The eDPP function does not intervene in the dynamic behaviour of the vehicle.

2.1.4 Safe Cruise

The Safe Cruise (SC) function enables an autonomously vehicle following at a safe distance on extra urban roads. Hence the function is designed to operate on rural roads and motorways. Besides observation of the environment and surrounding traffic by the function, the SC function needs to monitored the driver in order to ensure that the driver does not perform excessive secondary tasks while the SC is active. For this purpose a camera inside of the vehicle is used.

If the SC function is activated, the vehicle will follow the current lane automatically. For this purpose the function intervenes in the driving behaviour of the car by means of steering actuator. The lanes as well as other road users are detected by means of front camera sensor, a LIDAR sensor and front, side and rear radar sensors. The driven speed is set to the current speed limit, which is detected by the function or – if no speed limit is available - to the driver's set speed in order to make sure a safe speed is kept.

If there is another vehicle in front of the host-vehicle, the function will adjust the distance between both vehicles to the driver's preferred headway. Due to the autonomous accelerating and braking of the vehicle the function ensures that the vehicle keeps a safe distance to the front vehicle.

The SC function uses different types of actuators in order to warn the driver or to intervene in the vehicle behaviour. For issuing a warning different devices (e.g. vibrating seatbelt) are used. The exact warning strategy will depend on the results of SP3. The actuators, which are used for the autonomously vehicle following, are:

- active accelerator pedal
- braking actuator
- steering actuator

If the function intervenes in the driving behaviour, the driver should have the opportunity to override or take back the control of the vehicle. The way how this is performed has not been specified yet.

2.2 INCA

The vertical subproject "INCA" includes the following five functions which are intended to avoid accidents:

- Lane Change Collision Avoidance [LCCA]
- Oncoming Vehicle Collision Avoidance/Mitigation [OVCA]
- Rear-End Collision avoidance [RECA]
- Run-Off Road Prevention [RORP]
- Run-Off Road Prevention (curve) [RORP (curve)]
- Side Impact Avoidance [SIA]

2.2.1 Lane Change Collision Avoidance

The Lane Change Collision Avoidance (LCCA) function should prevent collisions during intended or unintended lane changes. The function covers lane change situations with oncoming vehicles and vehicles approaching from behind.

In order to avoid a collision the function can intervene by means of the steering or braking actuator of the function – depending on the situation. But before the function intervenes in the driving behaviour of the host vehicle a potential collision opponent as well as a lane change must be correctly detected by the function. Therefore the function uses radar sensors (front and side/rear), a front camera sensor and information of a digital map. Based on the provided sensor information the function evaluates the threat of the situation and decides how to react on the situations.

If the function becomes active, the general warning and intervention strategy is common for all use cases. But the detailed warning and intervention strategy can differ for the two demonstrator vehicles. Also the use case for which the function is intended can differ per demonstrator vehicle depending whether a detection of an oncoming vehicle is feasible or not. First the driver is warned e.g. by a haptic device. If the driver does not react to the warning, the function intervenes by means of braking and steering actuator in the driving behaviour of the vehicle. In this case two situations have to be distinguished. In the first situation the initial lane, in which the function wants to steers back in order to avoid the imminent collision, is blocked by another vehicle. In this situation the function inhibits the gas pedal and initiates an autonomous braking. At the same time a visual warning (e.g. red LEDs) is issued to the driver of the host vehicle. In case a sufficient gap in the target lane is detected, the function performs a lateral intervention in order to steer the host vehicle into the target lane and to disarm the situation. In the second situation the initial lane is not blocked by another vehicle. In this case the lateral intervention is conducted directly.

The steering actuators, which are used by the function, will apply a maximum steering torque of 3 Nm respectively 4 Nm. This steering torque is comparable to the steering torque, which is applied by systems, which already have been introduced to the market[6,7]. Hence it is probably that the driver is able to override this steering torque.

2.2.2 Oncoming Vehicle Collision Avoidance/Mitigation

The Oncoming Vehicle Collision Avoidance/Mitigation (OVCA) function is intended for situations, in which an opponent vehicle is approaching the host vehicle in the same lane. The objective of the function is to warn both drivers and – if it is necessary – to apply the brakes of the host vehicle in order to give the oncoming vehicle more time to change lane back to the original lane. The second objective of the braking is to reduce the impact speed in case that the collision cannot be avoided.

The main challenge related to the function is the correct detection of an oncoming vehicle, since there is not much time left up to the collision due to the high relative velocity between both vehicles. Hence it must be decided fast, whether the situation is critical or not. Further it must be detected in which lane the oncoming vehicle is driving, since the function should only react to vehicles in the same lane as the host vehicle. For the detection of an oncoming vehicle radar sensor and camera sensor are used. Furthermore an understanding on the infrastructure (e.g. number of lanes) is essential in order to interpret the position of the detected objects correctly. This information is provided by the digital map. In addition V2V communication can also be used to receive further information on oncoming vehicles.

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[6] Schmidt, Haptische Signale in der Lenkung: Controllability zusätzlicher Lenkmomente, p.15

[7] N.N., New Lancia Delta: Italian bourgeoisie with great ambitions, http://www.autopressnews.com/2008/06/Lancia/Lancia_Delta.shtml

The different sensor information is used in order to evaluate the hazard potential of the situation. Depending on the result the braking actuator or warning devices can be applied. Before the function intervenes in the driving behaviour of the host vehicle, the driver of the host vehicle of the oncoming vehicle will be warned. Therefore the host vehicle can use e.g. the headlamps (flashing) or, if available, V2V communication.

2.2.3 Rear-End Collision Avoidance

The Rear-End Collision Avoidance (RECA) function prevents rear end accidents by autonomous braking and steering intervention. During normal driving the function determines continuously the risk of a collision based on the onboard sensor's information (front/side/rear radar sensor, front camera sensor, front LIDAR sensor). Therefore the position and motion of the host vehicle in relation to the lane marking and other detected object (stationary and moving and including VRU) is calculated. Especially information on the driving direction of the adjacent lanes is important, because it must be prevented that the host vehicle evades in an oncoming traffic lane, even if it is empty.

Based on the sensor information the function calculates continuously possible evasive trajectories. For this purpose the function must consider the traffic condition and – in case the host vehicle is a truck - the load of the vehicle.

If an imminent collision is detected, the appropriate reaction strategy to the situation with respect to warning or intervention will be determined by the function. First the RECA function warns the driver. If the driver does not react to the warning, the function will intervene by applying the braking actuator or steering actuator.

In which way the function reacts depends on the situation. The natural approach to a rear end conflict is braking in order to reduce the vehicle velocity. And In case of an unavoidable collision this approach also reduces the impact velocity. During the braking the salience of the host vehicle's brake lights is enhanced, e.g. by flashing and /or increased intensity.

If the function detects during a braking manoeuvre that the manoeuvre will not be sufficient, the function can additionally try to avoid the collision by steering. The precondition for an additional steering intervention is that there is e.g. a sufficiently wide shoulder to the right and no other obstacles. The functions checks, if the requirements are fulfilled and performs an automatic steering manoeuvre towards the shoulder.

The steering intervention without braking is chosen for situations with a very high relative velocity. Therefore the RECA function checks first, whether a steering avoidance manoeuvre is possible. Some of the performed checks are listed below:

- Is there no traffic approaching from behind in the adjacent lane?
- Are there no infrastructural obstacles ahead in the adjacent lane?
- Is there a sufficient headway to the lead vehicle?

If these conditions are fulfilled, the function takes over steering control and performs a steering avoidance manoeuvre in the adjacent lane. After the steering manoeuvre is completed, steering control is handed back to the driver.

There are some exceptions from the presented intervention approach:

- If the driver's braking response comes late, but still before the autonomous braking is initiated, the autonomous braking will be suppressed.
- If the conditions for steering avoidance are not fulfilled, autonomous braking is performed in order to reduce the speed at least.

In case of an intervention by the function the driver is not always able to override the function. There is a distinction however between a lateral and longitudinal intervention. A

lateral intervention can be overridden by the driver at anytime. The longitudinal intervention can be overridden by the driver in most of the situations. But if a collision can only avoidable by braking manoeuvre the driver will not be allowed to override the function, because it should prevent that the driver might panic and press the gas pedal accidentally.

2.2.4 Run-Off Road Prevention

The Run-Off Road Prevention (RORP) function prevents run-off road accidents by autonomous steering intervention on straight roads. In order to prevent run-off road accidents the RORP function must be able to identify lane markings and the position of the vehicle in the lane. Therefore it uses the onboard radar sensors (front, side and rear), camera sensor and the information provided by the digital map. Additional information on the status of the vehicle is considered by the function. Especially the direction indicator is used to determine, whether the road departure is intended or not. Based on the sensor data the function determines the hazard potential of the situation and whether a warning should be issued or the function needs to intervene.

If a drift towards the lane boundary is detected by the RORP function and the turn indicator is not activated, the function assumes that the impending lane departure is not intended, and issues a warning (e.g. steering wheel feedback and/or directional sound) to the driver in order to redirect the driver's attention to the situation.

If the driver does not respond on the warning before a road departure by the driver cannot be avoided, the RORP function will initiate an autonomous steering manoeuvre back to the road. The steering actuators, which are used by the function, will apply a maximum steering torque of 3 Nm respectively 4 Nm. This steering torque is comparable to the steering torque, which is applied by systems, which already have been introduced to the market[8,9]. Hence it is probably that the driver is able to override this steering torque.

2.2.5 Run-Off Road Prevention (curve)

The Run-Off Road Prevention (RORP) function in curve informs respectively warns the driver when there is an upcoming sharp curve and the vehicle's speed is too high for a safe negotiating of the curve. Hence the function should prevent a road departure in curve in advance.

In order to warn the driver due to an upcoming curve the function has to determine the vehicle position as well as the distance towards the next curve. Therefore the function uses its onboard sensors. For the calculation of a safe speed beside to the information on the curve also the information on the status of the truck needs to be considered (e.g. position of the centre of gravity). Based on the sensor information the function determines an appropriate reaction to the current situation.

If the host vehicle approaches a sharp curve with too high speed, the function will first inform the driver on the upcoming curve. If the driver does not react on this information, a warning will be issued to the driver in the second step. If the driver still does not respond to the warning, the RORP function will inhibit the accelerator pedal and performs a smooth braking in order to reduce speed. The inhibition of the accelerator pedal is further used in order to control the vehicle speed in the curve.

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[8] Schmidt, Haptische Signale in der Lenkung: Controllability zusätzlicher Lenkmomente, p.15

[9] N.N., New Lancia Delta: Italian bourgeoisie with great ambitions, http://www.autopressnews.com/2008/06/Lancia/Lancia_Delta.shtml

2.2.6 Side Impact Avoidance

The objective of the Side Impact Avoidance (SIA) function is to avoid so called "blind-spot accidents". Blind-spot accidents occur in situations, in which the driver of the host vehicle wants to perform a lane change, but another vehicle is in the blind spot or approaching rapidly from behind in adjacent lane.

In order to prevent dangerous “blind spot” situation a safe detection of the other vehicle in the adjacent lane is required. Based on the sensor information (e.g. rear/side radar sensor and side ultrasonic sensor) the distance and the relative speed to the lane boundary as well as the distance towards other vehicles are calculated.

The countermeasures to avoid the imminent accident are calculated based on the hazard potential of the situation. First the function warns the driver. If the driver does not react on this warning, the function will intervene in the lateral dynamic behaviour of the host vehicle. There are two types of later intervention possible:

1. preventing that any part of the vehicle leaves the host lane
2. steering back when the vehicle has already partly left the host lane (major part still in host lane).

The steering actuators, which are used to intervene in lateral direction, will apply a maximum steering torque of 3 Nm. respectively 4 Nm. This steering torque is comparable to the steering torque, which is applied by systems, which already have been introduced to the market[10,11]. Hence it is probably that the driver is able to override this steering torque.

2.3 EMIC

The vertical subproject EMIC, which is intended to develop low cost mitigation respectively avoidance functions for accidents, includes two functions:

- Collision Mitigation System
- Emergency Steer Assist

Both functions are described in this subchapter.

2.3.1 Collision Mitigation System

The Collision Mitigation System (CMS) function should mitigate the consequences of an imminent accident by intervention in the driving behaviour of the vehicle by means of braking or steering. The objective of the braking manoeuvre is to reduce impact speed. The objective of a steering intervention is to optimize the point of impact and the impact orientation in order to reduce consequences of the accident.

Due to the two available mitigation strategies it is essential to choose the best mitigation strategy depending on the current situation. Therefore the function observes the surrounding traffic by means of the onboard radar and camera sensors. Based on this information the function determines whether a collision is imminent. If an unavoidable collision is detected the function will calculate the probable point of impact and possible alternative impact points. For theses points an assessment is made regarding the resulting passenger injuries. Based on these calculations an intervention strategy is chosen to guide the vehicle to the most

[10] Schmidt, Haptische Signale in der Lenkung: Controllability zusätzlicher Lenkmomente, p.15

[11] N.N., New Lancia Delta: Italian bourgeoisie with great ambitions, http://www.autopressnews.com/2008/06/Lancia/Lancia_Delta.shtml

favourable point of impact. Depending on the intervention strategy the braking and steering actuators are applied.

Besides the intervention by braking or steering the function also warns the driver by an acoustical, a visual and a haptic warning. But the exact warning strategy has not been defined yet, since it will base on the results of SP3.

The warning and intervention strategy of the function depends not only on the criticality of the situation, but also on the driver reaction. Therefore depending on the driver reaction, four different reaction of the function can be distinguished:

- Option 1: Strong driver reaction after warning

  If the driver reacts strongly after the warning is issued, the CMS will not initiate an intervention. The driver will only be supported by the standard braking assist.
- Option 2: Weak driver reaction after warning

  If a warning about an imminent collision has been issued and the driver reacts too weakly, the reaction of the function depends on the reaction of the driver. If the driver starts to brake, the driver is supported during the braking by the function. If the driver starts to steer, the function intervention is stopped or is disabled. Further the function will not intervene, if the driver presses the accelerator pedal.
- Option 3: No reaction of the driver after warning

  If a warning about an imminent collision is given and the driver does not react until the collision becomes unavoidable, the CMS will be activated. The function will brake as much as possible or steer in order to reduce the accident severity.
- Option 4: Intervention without warning

  If a warning about an imminent collision cannot be issued (e.g. due to the sensor limitations), the CMS will intervene in the vehicle behaviour. The function will brake or steer, to reduce the accident severity.

Any braking and/or steering intervention of the CMS function can be overridden by the driver.

2.3.2 Emergency Steer Assist

The Emergency Steer Assist (ESA) shall support the driver in dangerous situations, in which the driver tries to avoid an imminent collision by steering. In order to support the driver in dangerous situations the function observes the surrounding environment. If an imminent collision is detected by the onboard sensors (radar sensor and camera sensor) and the driver starts a steering manoeuvre to avoid the collision, the function will adjust the available chassis systems (in this case mainly by the Electric Power Steering (EPS)) to stabilize the vehicle and to support the driver by conducting a safe and stable steering manoeuvre.

The intervention strategy is in all use cases common:

1. detection of the situation
2. warning the driver about the situation
3. calculating and choosing the evasive strategy based on the driver reaction
4. if the driver starts to steer, providing support during the steering manoeuvre

The electric power steering actuator is used to apply the necessary additional steering torque for a safe evasive manoeuvre. It is important to point out that the function does not help to avoid the accident if the driver does not start a steering manoeuvre her/himself. The function only supports the driver, when he/she reacts with a too weakly or too strongly steering manoeuvre.

2.4 Functions' limitations

Important aspects of the interactIVe functions are limitations of the developed functions. The functions are not able to work under all environmental condition. In this subchapter the different limitation for the functions are discussed on a general level and not in detail, since interactIVe is a research project and will not develop market ready functions. Hence the available information on the function limitation is vague and changes can be expected, when such function should be introduced in the market in the future.

Most of the given limitations for the functions exist due to the limitation of the used sensors. LIDAR sensors for example have difficulties in adverse weather conditions (e.g. heavy rain or heavy snow). But also the functionality of camera sensor cannot be ensured in bad weather conditions or poor light conditions. Due to the lack of sensor information the functions will not be able to operate in these weather conditions.

For the road type, on which the function can be used, there are also limitations for some interactIVe functions. The usage of the functions can be limited to a certain road type (motorways, rural road or urban road). The reasons for such a limitation can be that the function is designed to work only in special situation (e.g. SC is intended to work on extra-urban road) or that the functionality – manly in urban regions – cannot be ensured. For the functions (e.g. SIA, LCCA and CS), which should prevent drift out of lane accident, information of the position of the vehicle in the lane is needed. In order to determine the vehicles position lane markings are required. Therefore the functions are only available if the lane boundary can be identified by the function. A further limitation regarding the road is that some functions (e.g. LCCA) will not work in sharp curves, since the steering actuator cannot apply an additional steering torque, which is needed to ensure that the vehicle is kept in the lane.

The availability of some functions is also limited due to the movement of the host vehicle respectively of the target object. There is for example for the RORP a limitation regarding the lateral velocity of the target object. The limitation is integrated in the function in order to ensure a reliable detection of the target. For nearly all function there are limitations regarding the speed range, in which the functions work. The SECONDS functions work from stand still up to an upper boundary speed range (e.g. SC and eDPP up to 130 km/h). For the INCA functions the speed range includes also a lower boundary. The lower boundary is integrated for different reasons. For the SIA function the boundary should prevent false detections e.g. at parking lots. For the function RECA a misuse of the function as a parking aid system should be prevent by means of the lower speed boundary.

3 Vehicle Type Approval Requirements

Vehicles of any kind have to be approved for traffic. This process usually incorporates the assignment of a registration number and requires the vehicle to conform to specific requirements, e.g. for vehicle safety or environmental aspects.

The mandate to approve vehicles for traffic belongs to the government of each country, with most countries however accepting those requirements defined by the United Nations Economic Commission for Europe's World Forum for the Harmonization of Vehicle Regulations (UN ECE WP.29). There are two different types of vehicle regulations: The 1958 agreement [12]system which requires vehicles to be certified by an independent technical service (Europe, Japan, rest of the world) and the 1998 agreement[13] which requires the vehicle manufacturers to certify their vehicles themselves (USA, China, most of the 1958 states).

3.1 Requirements for type approval according to UN ECE 1958 agreement

The 1958 agreement with its' ECE regulations covers most of the world with the exception of the United States and China. It therefore is considered as the most important set of vehicle regulations.

ECE regulations provide requirements for functional systems of a vehicle or a vehicle itself. The interactIVe demonstrator vehicles are based on production vehicles that are produced and therefore conform to type approval regulations. The added functionality involves warning systems and intervening systems. 'Warning only' systems are not covered by ECE regulations. Intervening systems are allowed as long as they conform to relevant regulations.

Intervening systems act on the vehicle brakes, throttle and steering systems. The following regulations are of relevance concerning the type approval of the added functionality:

13	Uniform provisions concerning the approval of vehicles of categories M, N and O[14] with regard to braking
13-H	Uniform provisions concerning the approval of passenger cars with regard to braking
79	Uniform provisions concerning the approval of vehicles with regard to steering equipment
Not yet def.	"Proposal for a Regulation on advanced emergency braking systems"

[12] AGREEMENT CONCERNING THE ADOPTION OF UNIFORM TECHNICAL PRESCRIPTIONS FOR WHEELED VEHICLES, EQUIPMENT AND PARTS WHICH CAN BE FITTED AND/OR BE USED ON WHEELED VEHICLES AND THE CONDITIONS FOR RECIPROCAL RECOGNITION OF APPROVALS GRANTED ON THE BASIS OF THESE PRESCRIPTIONS (former title: Agreement Concerning the Adoption of Uniform Conditions of Approval and Reciprocal Recognition of Approval for Motor Vehicle Equipment and Parts)

[13] Agreement concerning the establishing of global technical regulations for wheeled vehicles, equipment and parts which can be fitted and/or be used on wheeled vehicles

[14] M1: conventional passenger cars up to 8 passenger seats, M2: up to 5 tons gross mass, M3: more than 5 tons gross mass. N1: commercial vehicles not exceeding a gross mass of 3.5 tons, N2: commercial vehicles not exceeding a gross mass of 12 tons, and N3: commercial vehicles exceeding a gross mass of 12 tons.O:_trailers including semi-trailers.

Regulation 13-H allows the approval of electronic brake systems but is only applicable to passenger cars. Regulation 13 will be examined in order to find out the limitations it poses to the adaption of interactIVe functions to production commercial vehicles. The requirements for advanced emergency braking systems according to the upcoming regulation will be summarised, but as they are under discussion as well as the warning and intervention strategies of interactIVe are also under development, the upcoming regulation is not part of the further analysis (chapter 4).

3.1.1 Requirements for steering systems – ECE R79

Regulation ECE R79 is applicable to vehicles of category M, N and O (see e.g. [10]). It does not permit the approval of autonomous steering systems, defined as "a system that incorporates a function within a complex electronic control system that causes the vehicle to follow a defined path or to alter its path in response to signals initiated and transmitted from off-board the vehicle. The driver will not necessarily be in primary control of the vehicle" [15].

Moreover, according to 5.1.6. ECE-R 79 "*advanced driver assistance steering systems shall only be approved in accordance with this Regulation where the function does not cause any deterioration in the performance of the basic steering system. In addition they shall be designed such that the driver may, at any time and by deliberate action, override the function*".[16]

Two modes of steering control are allowed:

"2.3.4.1: Automatically commanded steering function means the function within a complex electronic control system where actuation of the steering system can result from automatic evaluation of signals initiated on-board the vehicle, possibly in conjunction with passive infrastructure features, to generate continuous control action in order to assist the driver in following a particular path, in low speed manoeuvring or parking operations." [17]

However the use of this function is limited to low speeds:

"Automatically commanded steering [...] shall be automatically disabled if the vehicle speed exceeds the set limit of 10 km/h by more than 20 % or the signals to be evaluated are no longer being received" [18].

"2.3.4.2: Corrective steering function means the discontinuous control function within a complex electronic control system whereby, for a limited duration, changes to the steering angle of one or more wheels may result from the automatic evaluation of signals initiated on-board the vehicle, in order to maintain the basic desired path of the vehicle or to influence the vehicle's dynamic behaviour" [19]

"Systems that do not themselves positively actuate the steering system but that, possibly in conjunction with passive infrastructure features, simply warn the driver of a deviation from the ideal path of the vehicle, or of an unseen hazard, by means of a tactile warning transmitted to the steering control, are also considered to be corrective steering" [20].

[15] Regulation No. 79, page 6,

[16] Regulation No. 79, page 13

[17] Regulation No. 79, page 6,

[18] Regulation No 79, page 14

[19] Regulation No. 79, page 7

[20] same

All complex electronic systems need to be developed according to functional safety requirements, e.g. as laid down in regulation 79 or in the upcoming ISO 26262 normative standard for functional safety. The latter is also relevant with regard to product liability.

For interactIVe, considered that the interactIVe functions are added to systems and system architectures that have already been type-approved, only the added functions themselves are relevant. The regulation R79 does allow

- autonomous steering control (without the driver being in the steering loop) at low speeds (< 12 km/h) and
- steering assistance (with the driver in the loop) only for a limited time, to maintain the basic desired course or to influence the vehicle's dynamic behaviour.
- All signals used for the control system must be initiated on-board.
- Tactile warning on the steering wheel is allowed.

All other interventions through the steering actuator are not allowed.

3.1.2 Requirements for brake systems for passenger cars – ECE R13h

The regulation ECE R13h does not explicitly address autonomous brake intervention. Additional functions are permitted if they conform to the specifications laid down in the regulation. The additional functions need to be declared (see e.g. 5.2.8. "The action of the service brake system shall be distributed between the wheels of one and the same axle symmetrically in relation to the longitudinal median plane of the vehicle. Compensation and functions, such as anti-lock, which may cause deviations from the symmetrical distribution, shall be declared".)

Checking the operational status should be possible, see e.g. 5.1.4.2: "It shall be possible to verify, in a simple way, the correct operational status of those complex electronic systems which have control over braking. If special information is needed, this shall be made freely available. At the time of type approval, the means implemented to protect against simple unauthorized modification of the operation to the verification means chosen by the manufacturer (e.g. warning signal) shall be confidentially outlined.

Alternatively, this protection requirement is fulfilled when a secondary means of checking the correct operational status is available."

Further requirements for common systems such as the ESC and the Brake Assist are added after these systems have been developed and brought to the market.

As mentioned above for the steering system, an analysis of the functional safety of any complex control system needs to be conducted: "The requirements of Annex 8 shall be applied to the safety aspects of all complex electronic vehicle control systems which provide or form part of the control transmission of the braking function included those which utilize the braking system(s) for automatically commanded braking or selective braking.

However, systems or functions, which use the braking system as the means of achieving a higher level objective, are subject to annex 8 only insofar as they have a direct effect on the braking system. If such systems are provided, they must not be deactivated during type approval testing of the braking system."

Brake lights will need to be turned on depending on the deceleration level (5.2.22): "Activation of the service braking system by the driver shall generate a signal that will be used to illuminate the stop lamps.

Activation of the service braking system by "automatically commanded braking" shall generate the signal mentioned above. However, when the retardation generated is less than 0.7 m/s^2, the signal may be suppressed.

Activation of part of the service braking system by "selective braking" shall not generate the signal mentioned above."

If the vehicle is equipped with an emergency braking signal, that signal also needs to be turned on (5.2.23): "When a vehicle is equipped with the means to indicate emergency braking, activation and de-activation of the emergency braking signal shall meet the specifications below: The signal shall be activated by the application of the service braking system at a deceleration of or above 6 m/s^2; The signal shall be de-activated at the latest when the deceleration has fallen below 2.5 m/s^2. The following conditions may also be used:

(a) The signal may be activated by the application of the service braking system in such a manner that it would produce, in an unladen condition and engine disconnected, under the test conditions of Type-0 [21] as described in annex 3, a deceleration of or above 6 m/s^2;

The signal shall be de-activated at the latest when the deceleration has fallen below 2.5 m/s^2, or at the time of type approval, compliance with this requirement shall be confirmed by the vehicle manufacturer.

(b) The signal may be activated when the service braking system is applied at a speed above 50 km/h and the antilock system is fully cycling (as defined in paragraph 2. of annex 6). The signal shall be deactivated when the antilock system is no longer fully cycling.

For interactIVe, considered that the interactIVe functions are added to systems and system architectures that have already been type-approved, only the added functions themselves are relevant. Automatically commanded braking is permitted, as long as the function is declared. Brake lights and emergency braking signals will need to be turned according to the criteria defined.

3.1.3 Requirements for brake systems for other four-wheeled vehicles – ECE R13

As above, the regulation ECE R13h does not explicitly address autonomous brake intervention. Additional functions are permitted if they conform to the specifications laid down in the regulation. The additional functions need to be declared, see e.g. 5.2.1.8: "The action of the service braking system shall be distributed between the wheels of one and the same axle symmetrically in relation to the longitudinal median plane of the vehicle. Compensation and functions, such as anti-lock, which may cause deviations from this symmetrical distribution, shall be declared[22]."

Checking the operational status should be possible, see e.g. 5.1.4.2: "It shall be possible to verify, in a simple way, the correct operational status of those complex electronic systems which have control over braking. If special information is needed, this shall be made freely available. At the time of type approval, the means implemented to protect against simple unauthorized modification of the operation to the verification means chosen by the manufacturer (e.g. warning signal) shall be confidentially outlined.

[21] A Type-0 test is an ordinary performance test with cold brakes.

[22] This must be declared to the technical service that issues the vehicle type-approval, during the process of vehicle type-approval.

Alternatively, this protection requirement is fulfilled when a secondary means of checking the correct operational status is available."

Functional safety requirements are found in annex 18: "The requirements of Annex 18 shall be applied to the safety aspects of all complex electronic vehicle control systems which provide or form part of the control transmission of the braking function included those which utilize the braking system(s) for automatically commanded braking or selective braking.

However, systems or functions, which use the braking system as the means of achieving a higher level objective, are subject to annex 18 only insofar as they have a direct effect on the braking system. If such systems are provided, they shall not be deactivated during type approval testing of the braking system."

Brake lights need to be activated in specific cases: "Activation of the service braking system by "automatically commanded braking" shall generate the signal mentioned above. However, when the retardation generated is less than 0.7 m/s^2, the signal may be suppressed.

Activation of part of the service braking system by "selective braking" shall not generate the signal mentioned above."

For interactIVe, considered that the interactIVe functions are added to systems and system architectures that have already been approved; only the added functions themselves are relevant. Automatically commanded braking is permitted, as long as the function is declared.

3.1.4 Requirements for advanced emergency brake systems

The European Commission requires vehicles of the category $M_{2,3}$ and $N_{2,3}$ (busses above 3.5 tons gross weight, commercial vehicles above 3.5 tons gross weight) to be equipped with advanced emergency brake systems (from November 2013 onwards for new type-approvals, November 2015 onwards for all vehicles). However there is no further information about the specifications for such a system available within the EU regulation framework. The UN ECE addresses the systems with an upcoming regulation.

That proposed regulation will require an adequate ABS system according to R13, it will also require electromagnetic compatibility according to R10 and functional safety similar to R13, R13h and R79.

Emergency braking phase shall start at TTCs of 3.0s or lower, and the minimum speed reduction during the validation tests shall be no less than 10 km/h. Warning modes shall be two out of the three acoustic, haptic and optical.

The status of the regulation can be monitored on the UN ECE web page[23].

3.2 Requirements for type approval according to UN ECE 1998 agreement

To the date of this report (June 2011), global technical regulation No. 8 defines performance criteria for ESC systems. However, it does not address additional functionality in the brake system and therefore permits this.

All other global technical requirements address topics not relevant to the functions defined in interactIVe.

[23] http://live.unece.org/trans/main/wp29/wp29wgs/wp29grrf/grrf-infaebsldw15.html

3.3 Requirements Summary

Brake intervention	For interactIVe, considered that the interactIVe functions are added to systems and system architectures that have already been type-approved, only the added functions themselves are relevant. Automatically commanded braking is permitted, as long as the function is declared. Brake lights and emergency braking signals will need to be turned on according to the criteria defined.
Steering intervention	Vehicle functions need to fulfil the following requirements: For interactIVe, considered that the interactIVe functions are added to systems and system architectures that have already been type-approved, only the added functions themselves are relevant. The regulation R79 does allow • autonomous steering control (without the driver being in the steering loop) at low speeds (< 12 km/h) and • steering assistance (with the driver still in the control loop) only for a limited time, to maintain the basic desired course or to influence the vehicle's dynamic behaviour. • All signals used for the control system must be initiated on-board. • Tactile warning on the steering wheel is allowed. All other interventions (e.g. autonomous steering at higher speeds) through the steering actuator are not allowed.
General requirements	The added functionality needs to conform to specific functional safety requirements, either defined within R13, R13h and R79 or e.g. in ISO 26262. All systems also need to conform to electromagnetic compatibility requirements defined in R10.

Table 3.1: Requirements for type approval according to UN ECE 1998 agreement

It should be noted that UNECE regulations define requirements for (sub-)systems (e.g. brake system, steering system), not for functions (e.g. change of course, change of deceleration), e.g. regulation 13h applies even if a brake system would be used to steer a vehicle, and regulation 79 applies even if a steering system is used to brake a vehicle. This point of view differs from the legal framework (see chapter 5), where a function is relevant, regardless of the system that is used to implement the function.

4 Possible Vehicle Type Approval for vehicles with interactIVe Functions

This section of the document analyzes the specific functions defined within the interactIVe project with regard to the requirements that are laid down in the previous chapter.

4.1 Continuous Support

The Continuous Support function provides support in the following cases:

- Exceeding speed limit (→ longitudinal intervention to adjust speed to speed limit)
- Lane Keeping (→ lateral intervention to steer the vehicle back into the lane)
- Dangerous lane exit (→ longitudinal intervention to decrease vehicle speed to safe levels)
- Curve approach (→ longitudinal intervention to decrease vehicle speed to safe levels)
- Crossing or roundabout approach (→ longitudinal intervention to decrease speed to safe levels or full stop)
- Dangerous front obstacle (→ longitudinal intervention to brake vehicle)
- Lane change (→ lateral intervention to move vehicle back into its own lane)

All longitudinal interventions are covered by the UNECE regulations, as long as they conform to general functional safety requirements (see additional requirements).

All lateral interventions take place for a limited duration and are only initiated by on-board signals. Their goal is to ensure vehicle dynamic stability and / or maintain the basic desired path. Therefore they all are covered by UNECE regulations, as long as they conform to the additional requirements.

Vehicles incorporating continuous support can be type-approved according to current UN ECE regulations.

Note that the crossing or roundabout support involves vehicle-2-vehicle (V2V) communication and thus incorporates signals generated outside the vehicle. Lateral support would not be allowed in this case.

4.2 Curve Speed Control

The Curve Speed Control function does estimate a safe cornering speed. If the actual speed is too high for safe cornering, the driver will be warned and – after some time – the speed will automatically be reduced. The function only acts on the cruise control and for higher deceleration levels on the brake system and thus is covered by the relevant ECE R13h.

Vehicles incorporating curve speed control can be type-approved according to current UN ECE regulations.

4.3 enhanced Dynamic Pass Predictor

The function assists the driver in estimating whether the available overtaking distance is sufficient for a safe manoeuvre. The function does not use any actuators and thus is not relevant for any ECE regulation.

Vehicles incorporating enhanced dynamic pass predictor can be type-approved according to current UN ECE regulations.

4.4 Safe Cruise

The Safe Cruise function combines longitudinal control with lateral lane guidance and adds assistance during critical situations (e.g. rear-end collisions) and speeding.

Longitudinal distance between the host vehicle and a leading vehicle is kept within safe boundaries analogue to conventional adaptive cruise-control systems by means of brake and engine torque actuation. This is state of the art and of course permitted by relevant UNECE regulations.

Lateral lane guidance does conform to regulation 79 only as long as the support is applied for a limited amount of time, and as long as the basic desired course is maintained. The latter condition could be fulfilled by assuming that the desired course is defined by the road the vehicle travels on, but regulation 79 clearly states that assisted steering is only allowed for a limited duration.

Therefore vehicles implementing the safe cruise function (in normal operation mode) cannot be type-approved according to current regulation 79.

Production lane keeping systems do check whether the driver keeps the hands on the steering wheel and define the limited duration implicitly as the time the driver has his or her hands upon the wheel, and / or even use a relatively complex algorithm to make sure the driver is still awake and conscious.

In driving situations with an increased accident risk (e.g. TTC approaches values of a few seconds), safe cruise will actuate the vehicles' brakes and either apply a small amount of steering torque (as some kind of tactile feedback, which is allowed) or perform an evasive steering manoeuvre (which is not allowed as the evasive manoeuvre neither helps in keeping the basic desired course nor stabilizes the vehicle behaviour).

Vehicles implementing only the tactile feedback on the steering wheel could be type-approved according to current regulation 79, but vehicles performing an automatic evasive manoeuvre could not.

Vehicles incorporating safe cruise do not conform to UN ECE 79 as the automatic steering for an unlimited amount of time is not allowed (normal operation), and automatic evasive manoeuvres are also not allowed (critical situations).

4.5 Lane Change Collision Avoidance

The Lane Change Collision Avoidance (LCCA) function acts on steering system and brakes in order to prevent imminent collisions while overtaking or being overtaken. After issuing warnings, the function steers the host vehicle (= vehicle equipped with the function) back into

its own lane, by actuation on the steering system. If the own lane is blocked (e.g. during overtaking a slower vehicle), an autonomous braking manoeuvre is conducted beforehand.

The braking manoeuvre is covered by UNECE regulations. However, the steering manoeuvre cannot be considered as assisting to maintain the basic desired course. Therefore the function is not covered by current regulation ECE R79. If the steering would have been carried out by selective braking, ECE 79 would not be relevant and vehicles implementing the system could be type-approved.

Vehicles incorporating LCCA function cannot be type-approved according to current UN ECE regulations because of autonomous steering that does not help in vehicle stabilization nor maintains the basic desired course.

4.6 Oncoming Vehicle Collision Avoidance / Mitigation

The Oncoming Vehicle Collision Avoidance and Mitigation function helps preventing oncoming collisions. Two different modes need to be distinguished: if the host vehicle (with the function) travels straight ahead in its own lane and is approached by an overtaking vehicle on the same lane, warnings are issued to the driver of the host vehicle and to the driver of the oncoming vehicle (e.g. flashing the headlights), and automatic braking is initiated.

The function is covered by ECE 13 and 13h. Warnings that are sent to the oncoming vehicle via headlights need to conform to the relevant headlight regulations (e.g. ECE R8 etc).

The autonomous braking function however does conform to the relevant regulations ECE R13 and R13h.

4.7 Rear End Collision Avoidance

The Rear End Collision Avoidance function is available for passenger cars as well as trucks. The function assesses the collision risk and intervenes by steering intervention (for high relative velocities, and if possible taking into account surrounding traffic) and / or braking intervention (else). No external signals are used for the function, and steering control is handed back to the driver after the critical driving situation. However, it does not help to stabilize the vehicle dynamic behaviour nor does maintain the basic desired course. Steering control therefore is not permitted by ECE 79.

The host vehicle (in which the function is implemented) will show a specific brake signal during braking (e.g. flashing brake lights). It needs to be assured that the brake signal does conform to the conditions for emergency brake signals as defined in ECE 13.

Vehicles incorporating rear end collision by steering do not conform to UN ECE 79 as the lane change neither does stabilize the vehicle dynamic behaviour nor does maintain the basic desired path of the vehicle.

Vehicles incorporating rear end collision avoidance by braking can be type-approved according to current UN ECE regulations. Make sure the emergency brake signal conforms

to the relevant regulation ECE 13h.

4.8 Run Off Road Prevention (straight road)

The Run Off Road Prevention function (straight road) prevents the vehicle from accidentally leaving its lane while going straight ahead. It actuates the steering actuator to move the vehicle back to its lane. No external sensor signals are used and the steering input only acts for a limited amount of time. This function is permitted by ECE R79 since the basic desired path of the driver is maintained.

Vehicles incorporating run off road prevention (straight road) can be type-approved according to current UN ECE regulations.

4.9 Run Off Road Prevention (curve)

The maximum lateral acceleration and thus maximum cornering speed (for a given curve) for large commercial vehicles is limited by the tire friction for relatively low road-tire friction values, but mainly by the vehicle's roll-over behaviour which depends on the height and position of the vehicle's centre of gravity.

The run off road prevention function (curve) is implemented in such a vehicle (Volvo truck). It determines a safe cornering speed for the curve ahead, based on map data and vehicle centre of gravity position. Whenever a curve is approached with an unsafe speed, the vehicle is braked to the safe speed (during approach phase), and the vehicle will be prevented from accelerating (during approach and cornering phases).

Only longitudinal intervention is used. Longitudinal intervention is permitted by the relevant regulation ECE-R13, as long as the function is declared.

Vehicles incorporating run off road prevention (curve) can be type-approved according to current UN ECE regulations.

4.10 Side impact avoidance

The Side Impact Avoidance function does prevent lane changes of the host vehicle in cases where there is traffic in the adjacent lanes. The function is available for passenger cars (pure steering actuation) and trucks (not decided whether steering actuation or individually braked wheels will be used).

Since only on-board sensor signals are evaluated and the steering assistance is only used for a limited amount of time, the function is permitted by ECE 79, 13 and 13h IF the basic desired course is maintained – that is, if the lane change only happens accidentally. A criterion to prove this fact could be the lateral velocity.

Vehicles implementing side impact avoidance can be type-approved according to current UN ECE regulations, IF the lane change happens accidentally (e.g. for low lateral velocities).

4.11 Collision Mitigation System

The collision mitigation system (CMS) is designed to reduce the severity of an accident and is basically comparable to conventional automatic emergency braking systems available on the market today, with the addition of automated steering in some situations.

The enhancement over today's systems is obviously the steering function which is used to mitigate the severity not by performing evasive manoeuvres (e.g. steering away from the obstacle) but by optimizing the impact constellation.

The function's responses to critical driving situations depend on the driver reaction. If the driver reacts, the brake force will be increased up to the physical limits if necessary. No steering is necessary; this type of response conforms to current regulations.

In case of no driver reaction, the system reacts only after the collision is not avoidable (that must include braking and swerving around the obstacle). In this case, brake force will be applied (again, this conforms to regulations 13 and 13h, if the function is declared appropriately), and the steering will be actuated (most presumably to align the centre lines of both vehicles).

This steering actuation could be regarded as (not allowed) automated steering which neither stabilizes the vehicle nor helps the driver keeping the basic desired course. However, vehicle stabilization could be extended to the post-crash phase: yaw stability in the post-crash phase is highest with no overlap between the vehicles.

It is not clear how the CMS function would be treated during type-approval.

The treatment of vehicles incorporating collision mitigation system during type-approval according to current UN ECE regulations is not clear. Further clarification in the regulations would be useful.

4.12 Emergency Steer Assist

The Emergency Steer Assist function monitors the vehicle's surrounding traffic. If a collision is detected and the driver starts an evasive manoeuvre, the emergency steer assist adjusts the chassis systems. If the driver steers too weak or strong to pass the obstacle, the assist function applies an additional steering torque in order to increase respectively decreases the driver's steering torque. Sensor information is used only from on-board sensors.

This assistance function helps to maintain the basic desired course (which in this case is a course to pass the obstacle). This is permitted according to ECE R79.

Vehicles incorporating emergency steer assist can be type-approved according to current UN ECE regulations.

4.13 Summary and recommendations

Most functions defined within interactIVe already conform to current UNECE regulations. Those systems that implement steering functions which neither help in keeping the basic desired course nor stabilize the vehicle do not conform to current UNECE regulations.

Table 4.1 summarizes the results of the detailed analysis of all interactIVe functions and also mentions the reasons. Recommendations for further development of relevant regulations are derived from this table.

interactIVe function	Result	Reasons
Continuous Support	OK	
Curve Speed Control	OK	
enhanced dynamic pass predictor	OK	
Safe Cruise	Not OK	Steering intervention not for a limited time (Reg. 79).
Lane Change Collision avoidance	Not OK	Steering intervention neither helps in keeping the basic desired course nor stabilizes the vehicle.
Oncoming vehicle collision avoidance / mitigation	OK, see comment	Flashing headlights as warning signal must conform to relevant headlight regulations.
Rear end collision avoidance	Not OK for steering, see comment	Specific brake light signal needs to conform to ECE 13 and 13h. Steering intervention neither helps in keeping the basic desired course nor stabilizes the vehicle (Reg. 79).
Run off road prevention (curve)	OK	
Run Off Road Prevention (straight road)	OK	
Side impact avoidance	OK	
Collision Mitigation System	Not clear, see text	Steering intervention neither helps in keeping the basic desired course nor stabilizes the vehicle. But the function acts autonomously only if the accident cannot be prevented (pure mitigation system). It is not clear whether this will conform to regulation 79.
Emergency Steer Assist	OK	

Table 4.1: Summary of possibilities for type-approval of interactIVe functions according to current regulations

4.13.1 Recommendations

The Safe Cruise function implements a behaviour that is already clearly addressed in regulation 79 (autonomous steering for an unlimited amount of time). This system behaviour is clearly forbidden. It can be assumed that the base for this decision during the definition of regulation 79 must have been the state of the art at that time (Revision 2 was released in April 2005). Reliability of driver assistance systems has been improved in the last six years, along with the improvement of computer technology and the development of functional safety methods.

If there is the decision to bring the Safe Cruise function to the market, the regulation would have to be modified, especially since safe cruise is mainly a comfort system.

The case is somewhat different for those interactIVe functions that clearly aim at the reduction of traffic fatalities (or at least injury severity). The main reason why the collision

avoidance and mitigation systems cannot be type-approved today is the definition that all steering interventions above 10 km/h (+2 km/h) driving speed need to either help in keeping the basic desired course or help in stabilizing the vehicle. The situation needs to be clarified for pure mitigation systems (it is not clear whether these systems would be allowed), but also the idea of performing autonomous manoeuvres to protect the host vehicle (and even more – protect other vehicles) is not implemented in regulation 79 up to now.

A discussion is needed addressing the issue how these functions behave in cases where the consequences of a steering intervention is not so clear. This topic needs to be discussed with a broader view, also incorporating product liability and – and of course the 1968 Vienna Convention on Road Traffic.

As for the rear-end collision avoidance function, the issue with the specific brake signal is a minor issue which would involve some discussion but does not introduce new ideas into the relevant regulation.

5 Legal Framework on EU-level

In addition to the issues concerning ECE-Regulations as described above the applications being developed within the interactIVe project raise different questions from a legal point of view. WP 77 concentrates on an analysis identifying the relevant legal framework on EU- and ECE-level, i.e. the relevant regulations and directives. The intended purpose is to investigate if certain regulations might hinder the introduction of new technologies and applications such as the applications developed within the interactIVe project.

The technical descriptions of the functions make clear that particular functions being developed within the interactIVe-project are intended to feature an increased degree of automation compared to such driver assistance systems already available on the market. The Safe Cruise function for example is intended to provide for automatic vehicle following on extra urban roads. Therefore it includes automatic actuation of the steering wheel, the brakes and the power train. The driver is being monitored by a camera while the Safe Cruise function is active in order to detect if he or she is still concentrating on the traffic; Safe Cruise is intended to be deactivated if the driver performs secondary tasks excessively.

Different degrees of automation require a differentiated legal evaluation. The basis for such a differentiated legal evaluation is the description respectively the definition of those different degrees of automation. The BASt-project group “Legal consequences of an increase in vehicle automation” is currently working on defining and compiling different degrees of automation relevant from a legal point of view. The BASt-project group’s final report including definitions and legal findings will presumably be published a few months after this deliverable is being written so that these findings may additionally be accounted for at a later stage of the interactIVe project.

5.1 Vienna Convention on Road Traffic – International Road Traffic Law / Behavioural Law

Regarding the legal framework, different fields of law have to be taken into account. Considering behavioural law in terms of road traffic law the EU Member States share a common heritage which can be found even above the EU-level on the level of international law which is reflected in the individual EU Member States´ road traffic regulations: The 1968 Vienna Convention on Road Traffic[24] forms the international law’s framework for the embodiment of traffic law in the legal systems of the contracting parties. Consequently, national law must not run contrary to the Vienna Convention (VC) which arises – inter alia – from Art. 3 (1) (a) VC:

> *“Contracting Parties shall take appropriate measures to ensure that the rules of the road in force in their territories conform in substance to the provisions of Chapter II of this Convention.”*

Provisions which are relevant for the applications being developed within this project can predominantly be found in Articles 8 (5) and 13 (1) VC; moreover Articles 14 and 17 VC contain provisions which may turn out to be relevant for the functions as developed in the interactIVe project. Due to the Vienna Convention’s character as an international treaty obliging states, not the individual, the Convention does not provide any sanctions in case of infringements of the behavioural rules constituted in chapter II of the Vienna Convention so that the driver will not have to face any consequences based on the Vienna Convention. However, the EU Member States´ national road traffic regulations which reflect and adopt

[24] www.unece.org/trans/conventn/Conv_road_traffic_EN.pdf

parts of the VC (compare Art. 3 (1) (a) VC [see above]) may and do provide sanctions in case of a driver's infringements of the national traffic road regulations, of course.

5.1.1 Articles 8 (5) and 13 (1) of the Vienna Convention

Art. 8 (1) VC postulates that

> *"Every moving vehicle or combination of vehicles shall have a driver."*

Consequently, Art. 8 (5) VC constitutes the driver's obligation to be able to control his vehicle permanently:

> *"Every driver shall at all times be able to control his vehicle or to guide his animals."*

Art. 13 (1) VC substantiates this obligation with regard to speed and distance between vehicles; Art. 13 (1) VC says (in extracts):

> *"Every driver of a vehicle shall in all circumstances have his vehicle under control so as to be able to exercise due and proper care and to be at all times in a position to perform all manoeuvres required of him […]".*

National road traffic regulations such as the German Road Traffic Regulations (Straßenverkehrsordnung [StVO]) reflect this basic idea of permanent controllability.

In terms of permissibility of particular functions which are being developed within the interactIVe project the provisions of chapter II of the Vienna Convention (*"Rules of the Road"*) cannot be disregarded. On the one hand, partly the view is held that for the question of permissibility of driver assistance systems the behaviour-related provisions of chapter II of the Vienna Convention are of importance.[25] On the other hand, the applicability of Articles 8 and 13 VC in terms of permissibility is doubted arguing that chapter II of the Vienna Convention contains driver-related provisions, not vehicle-related or construction-related requirements.[26] The latter position is criticised because it means that the Vienna Convention would – on the one hand – allow the construction and admission (to traffic) of vehicles which – on the other hand – do not enable the driver to comply with the rules of chapter II of the Vienna Convention (respectively with the corresponding national behavioural rules).[27]

It is crucial that the Vienna Convention as a whole has to be understood as a unit which contains requirements concerning conditions for the admission of motor vehicles and trailers to international traffic (chapter III VC and annex 5 VC) as well as driver-behaviour-related requirements. In view of the actual correlation between a vehicle's technical construction on the one hand and its controllability on the other hand, the individual provisions of the Vienna Convention cannot be looked at separately but they have to be comprehended as a unit. Consequently, considering permissibility of driver assistance systems the provisions of Chapter II VC have to be taken into account. As mentioned above, national road traffic law must not run contrary to the Vienna Convention. Accordingly, it would be impermissible according to international law if a national legal system allowed the permissibility of a driver assistance system which runs contrary to the provisions of the Vienna Convention.[28]

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[25] Frenz/Casimir-van den Broek, NZV 2009, 529 (530)

[26] Bewersdorf, pp. 53, 54

[27] Albrecht, DAR 4/2005, 186, 196

[28] see Frenz/Casimir-van den Broek, NZV 2009, 529 (530.)

Interventions of driver assistance systems in the vehicle-guidance which do not comply with the driver's will and which cannot be corrected respectively overridden are considered as incompatible with controllability in terms of the Vienna Convention.[29]

Nevertheless, the technical design of driver assistance systems and with that the design of the individual functions developed within the interactIVe project may contribute to avoid practical consequences for the (non-)permissibility of the individual function respectively the system with regard to the Vienna Convention.

It can be assumed that a function providing for an automated braking intervention respectively an automated steering intervention occurring at a point in time at which the driver is unable to mitigate or avoid the accident all by himself will comply with the will of a carefully acting driver.[30] As long as an automated intervention takes place in a situation which is no longer controllable in any other way (e.g. due to the time the driver would need to react), it may consequently be assumed that those interventions do not run contrary to the above mentioned provisions of the Vienna Convention. So, even if the permissibility of a function providing for an automated braking or steering intervention is judged with regard to Articles 8 and 13 VC, controllability in terms of the Vienna Convention can be maintained as long as the intervention takes place in an area which is beyond human capability to react.

However, the basic idea of permanent controllability underlying the Vienna Convention which assigns the driving task to the driver (possibly being assisted by technical provisions in order to optimize his performance), makes it seem sensible to put forward the driver's will just as far as possible: In case of the detection of an impending collision the driver's will should be called forth by corresponding warning strategies. These warnings give the driver the basic opportunity to initiate braking or steering himself to mitigate or to avoid the accident – or even to override an upcoming intervention if necessary.

Moreover, in many cases controllability may be achieved by a function design that allows the driver to override the intervention.

5.1.2 Art. 14 of the Vienna Convention – General requirements governing manoeuvres

At first glance, Art. 14 VC (*"General requirements governing manoeuvres"*) might be of significant relevance for functions providing for automated braking or steering interventions; Art. 14 VC says (in extracts):

> *"1. Any driver wishing to perform a manoeuvre such as pulling out of or into a line of parked vehicles, moving over to the right or to the left on the carriageway, or turning left or right into another road or into a property bordering on the road, shall first make sure that he can do so without risk of endangering other road-users travelling behind or ahead of him or about to pass him, having regard to their position, direction and speed.*
>
> *[…]*

[29] see Gasser, Legal Aspects of Driver Assistance Systems, Aachen colloquium "Automobile and Engine Technology" 2010, Vol. 1 pp. 815-828; Albrecht, DAR 4/2005, 186, 196; Frenz/Casimir-van den Broek, NZV 2009, 529 (530 f.)

[30] see (with regard to automated emergency braking interventions only) Frenz/Casimir-van den Broek, NZV 2009, 529 (530 f.)

> *3. Before turning or before a manoeuvre which involves moving laterally, the driver shall give clear and sufficient warning of his intention by means of the direction-indicator or direction-indicators on his vehicle, or, failing this, by giving if possible an appropriate signal with his arm. The warning given by the direction-indicator or direction-indicators shall continue to be given throughout the manoeuvre and shall cease as soon as the manoeuvre is completed."*

These provisions are, inter alia, reflected by the national road traffic regulations, such as the German Road Traffic Regulations (sec. 7 (5) and sec. 9 (1) StVO).

Functions providing for automated steering interventions as developed in the interactIVe project (such as the RECA function) might possibly prevent the driver from ensuring that no other road-user is endangered by a sudden lateral movement of the vehicle as the driver might not be able to fulfil this requirement stated by Art. 14 (1) VC in case that the function intervenes rather abruptly or unexpectedly. Moreover, those functions might hardly give the driver the time to give clear and sufficient warning of the intention to move laterally (see Art. 14 (3) VC).

On the other hand, it has to be taken into account that these provisions of the Vienna Convention address the driver's duty to apply the appropriate carefulness. It complies with the driver's duty of care and may be regarded as a most important issue of carefulness that the driver tries to avoid endangering persons or traffic (Art. 7 (1) VC: "*Road-users shall avoid any behaviour likely to endanger or obstruct traffic, to endanger persons, or to cause damage to public or private property*"). Consequently, in a critical situation the driver's obligations derived from Art. 14 VC (ensuring that no other road-user is endangered; usage of direction-indicators) might possibly step back behind the driver's general duty to avoid endangering persons or traffic.

Moreover, the above mentioned provisions of Art. 14 VC make it seem recommendable that functions providing for an automated steering intervention should activate (and later on deactivate) the vehicle's direction-indicators automatically in case of a lane change or in case of a turn to the left or to the right in order to indicate the intended direction of the lateral movement of the vehicle and with that to assist the driver in fulfilling the requirements of Art. 14 VC. On the other hand, it could be argued that, if the automated steering intervention occurs in a critical driving situation in an area which is beyond human capability to react, it would not help much if the direction-indicators were activated because other road-users would not be warned in time so that the warning function of the direction-indicators for other road-users would be quite limited. However, the automatic activation and deactivation of the direction-indicators in case of automated steering interventions might contribute to assisting the driver in fulfilling the requirements of Art. 14 VC.

5.1.3 Art. 17 of the Vienna Convention – Slowing down

At first glance once again, with regard to functions providing for an automated emergency braking intervention, Art. 17 (1) VC (*"Slowing down"*) could be considered as significantly relevant:

> *"No driver of a vehicle shall brake abruptly unless it is necessary to do so for safety reasons."*

Generally, it can be assumed that an automated emergency braking intervention will be necessary for safety reasons because the intervention takes place in a situation in which the collision is tremendously close. For this reason already, no clash with Art. 17 (1) VC is identifiable.

According to Art. 17 (2) (1) VC every driver intending to slow down to an appreciable extent shall, except where his slowing down is in response to an imminent danger, first make sure that he can do so without danger or undue inconvenience to other drivers. Generally, an automated emergency braking intervention is based on the detection of an imminent danger (impending accident) so that no conflict with Art. 17 (2) (1) VC is identifiable in this context.

5.1.4 Summary – Provisions of the Vienna Convention

Considering the Vienna Convention with regard to the functions developed within the interactIVe project, the focus is on Articles 8 (5) and 13 (1) VC: Those provisions constitute the driver's obligation to be always in control of his vehicle. This basic idea of permanent controllability assigns the driving task to the driver and therefore makes it seem sensible to put forward the driver's will as far as possible. This may be achieved by means of a function design which allows the driver to override automated braking and/or steering interventions.

In case a function detects an impending accident the adherence to of the driver's will (in terms of controllability) can be enhanced by calling forth the driver's will by means of corresponding warning strategies. Information respectively warnings give the driver the basic opportunity to initiate braking or steering himself in order to avoid or to mitigate the collision – or even to override an upcoming automated braking and/or steering intervention if necessary. Moreover, automated braking and/or steering interventions do not run contrary to Articles 8 (5) and 13 (1) VC as long as the intervention occurs in area which is beyond human capability to react.

5.2 Product Liability Law

Another crucial aspect to be investigated concerning the functions developed within the interactIVe-project is product liability. It is remarkable that product liability systems in the EU Member States show a significant extent of similarity[31]: Liability claims arising from damages caused by a defective product may be based on three distinct liability systems: product liability (based on the Product Liability Directive 85/374/EEC), contract (contractual liability) and/or tort (extra-contractual liability). Those three liability systems are presented in the following.

5.2.1 Product Liability Directive 85/374/EEC

Product liability has been harmonized up to a certain degree within the EU based on the Product Liability Directive (85/374/EEC)[32] dating from 1985 (modified by EU Directive 1999/34/EU in 1999[33]) and was homogeneously embodied as a strict liability regardless of fault. Nevertheless, national law still takes an important part and may contain certain national particularities considering product liability.

Due to its legal character as a Directive the Product Liability Directive has been transferred into binding national law by the individual EU Member States. Art. 288 of the Treaty on the Functioning of the European Union [TFEU] (ex Art. 249 of the Treaty establishing the European Community [TEC], ex Art. 189 EEC Treaty of Rome [1957]) distinguishes between

[31] see Lovells, p. 9

[32] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31985L0374:EN:HTML

[33] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:1999:141:0020:0021:EN:PDF

several types of legal acts of the EU – inter alia between regulations and directives and says (in extracts):

> "*A regulation shall have general application. It shall be binding in its entirety and directly applicable in all Member States.*
>
> *A directive shall be binding, as to the result to be achieved, upon each Member State to which it is addressed, but shall leave to the national authorities the choice of form and methods.*" [34]

The EU Member States implemented the Product Liability Directive´s requirements by legislating corresponding laws between 1988 (Austria and Italy) and 1998 (France). In Germany the corresponding Product Liability Act (Produkthaftungsgesetz [ProdHaftG]) came into effect in 1990. Spain legislated the *Ley de Responsibilidad civil por los daños causados por productos defectuosos* in 1994. In France the *Loi no. 98-389 du 19 mai 1998* introduced the Articles 1386-1 to 1386-18 into the *Code Civil* and with that transacted the Product Liability Directive (85/374/EEC). The list could be continued. The Product Liability Directive (85/374/EEC) forms the common – but not the exclusive – background for product liability claims in the EU Member States. Art. 13 of the Directive declares that the Directive shall not affect any rights which an injured person may have according to the rules of the law of contractual or non-contractual liability or a special liability system existing at the moment when the Directive was notified. That means that bases for liability claims existent within the individual Member States´ laws when the Directive came into effect remain valid. Consequently, consumers can choose the cause of the action upon which to bring their claim or, in some jurisdictions, the courts can choose the basis upon which to award consumers´ compensation.[35]

The Product Liability Directive's crucial issues mandatorily to be transposed into national law can be summarized as follows:

- The producer is strictly liable for damage caused by a defect in his product (Art. 1).
- The burden of proof of damage, of the defect and of the causal relationship is to the injured person, i.e. to the claimant (Art. 4).
- Joint and several liability of any participant in the production process (manufacturer of a finished product or of a product's component[s] or of raw materials / importer / any person putting their name, trademark or other distinguishing feature on the product [own-brander] or any person supplying a product whose producer cannot be identified [Art. 3 and Art. 5]); the producer's liability shall not be reduced when the damage is caused both by a defect in product and by the act or omission of a third party; the producer's liability may be reduced or disallowed when the damage is caused both by a defect in the product and by the fault of the injured person or any person for whom the injured person is responsible (Art. 8).
- A product is defective when it "does not provide the safety which a person is entitled to expect"; relevant considerations include the way the product is presented, reasonable expectations of its use, and the time when it was put into circulation (Art.6).
- Proof of exoneration possible for the producer in case he can prove (see Art. 7) that:
  - he did not put the product into circulation; or
  - it is probable that the defect causing the damage did not exist at the time when he put the product into circulation or that this defect came into being afterwards; or

[34] consolidated version of the Treaty on the Functioning of the EU, 30.3.2010, Official Journal of the EU, C 83/171: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2010:083:FULL:EN:PDF

[35] see Lovells, p. 15

  - the product was not manufactured for sale or any form of distribution for economic purpose nor manufactured or distributed by him in the course of his business; or
  - the defect is due to compliance of the product with mandatory regulations issued by the public authorities; or
  - the state of scientific and technological knowledge at the time when he put the product into circulation was not such as to enable the existence of the defect to be discovered [Member States may derogate on this point, see Art. 15 (1) (b)]; or
  - in the case of a manufacturer of a component, that the defect is attributable to the design of the product or to the instructions given by the product manufacturer.
- "Damage" means damage caused by death or personal injury or damage to any item of property (other than the defective product itself) intended for private use; lower threshold: 500,- EUR (Art. 9).
- Limitation period: three years, beginning to run from the day on which the plaintiff became aware or should reasonably have become aware of the damage, the defect and the producer (Art. 10); expiry time frame: ten years from the date on which the producer put the actual product into circulation (Art. 11).
- Product Liability towards the injured person may not be limited or excluded (Art. 12).
- As mentioned above, national provisions already existing at the moment of the notification of the Directive remain valid (Art. 13).

These demands of the Product Liability Directive have been transposed to national laws. Art. 1 of the Directive constitutes that the producer shall be liable for damage caused by a defect in his product. In Germany for instance this was transacted in sec. 1 (1) ProdHaftG which deals with the producer's liability for damages to body, health and property caused by a defect of the product. Art. 6 of the Directive defines a product to be defective when it does not provide the safety which a person is entitled to expect, taking all circumstances into account, including the presentation of the product, the use to which it could reasonably be expected that the product would be put and the time when the product was put into circulation; Art. 6 also clarifies that a product shall not be considered defective for the sole reason that a better product is subsequently put into circulation. The wording of Art. 6 of the Directive was adopted completely in Art. 1386-4 of the French Civil Code as well as in sec. 3 of the German Product Liability Act (translated into French respectively German language, of course). In the context of the product's presentation mentioned in Art. 6 it is important to point out that advertisements and commercials can also have an impact on the general public's expectations concerning product safety.[36] It is not the individual user´s safety expectation which is crucial, but it is vital that the product provides that safety which the general public considers to be required according to the common opinion in the specific area.[37] In the context of the question if a product is considered to be defective, all circumstances have to be accounted for (see Art. 6) – this also includes circumstances not being explicitly mentioned in Art. 6 – this implies that jurisdiction may also define certain circumstances in that sense.

Since product liability cases are based on the EU Member States´ national laws [deriving from the Product Liability Directive] those cases are heard by national courts; so jurisdiction concerning product liability cases has to be regarded on a national level. In this context, Germany may serve as an example: German jurisdiction and juridical literature postulate that the product has to comply with the state-of-the-art of science and technology.[38] Technical standards and legal safety regulations constitute the minimum standard of safety whose adherence the general public legitimately expects; non-adherence to technical standards and legal safety regulations is regarded as a fault in construction and possibly a fault in

[36] see Palandt/Sprau, sec. 3 ProdHaftG, recital 5

[37] Palandt/Sprau, sec. 3 ProdHaftG, recital 3

[38] cp. Palandt/Sprau, sec. 3 ProdHaftG, recital 4; Wagner in Münchener Kommentar, sec. ProdHaftG, recital 22

instruction.[39] However, the adherence to those standards and regulations constitutes the assumption that the product / the instruction complies with the generally accepted rules of technology and with that complies with the safety expectations; the mere adherence is insufficient when the technical development / the scientific findings have gone beyond the standards and / or if any risks in the usage of the product appear which are not considered in the standards so far.[40] The adherence to technical standards is necessary but not necessarily sufficient in order to adhere to the state-of-the-art in science and technology. In the context of the fulfilment of the constructional and instructional obligations it has to be pointed out that the adherence to a system of rules like the *RESPONSE 3 Code of Practice for the Design and Evaluation of ADAS*[41] does not constitute an exclusion of liability but that it can serve as an evidence of the adherence to the necessary requirements of carefulness. Moreover, in this context ISO 26262 has to be mentioned which is still a draft at the moment this deliverable is being written: The International Organization for Standardization (ISO) plans to publish the ISO 26262 "Road Vehicles – Functional Safety" by the mid of 2011. Technical standards such as DIN- or ISO-standards are estimated to gain importance in defining criteria of liability even though these technical standards are not binding law but legally non-binding expert proposals.[42] ISO 26262 has been developed under participation of the automotive industry and is currently accessible for the public as a Final Draft International Standard (FDIS). As a consequence – even though it has not been published in its final version by the time this Deliverable is being written – there is expert knowledge de facto available (regardless of the fact if ISO 26262 is finalized or not) which must not be ignored when defining the state of technology.[43] Already when ISO 26262 was published as a Draft International Standard (DIS) in 2009, regarding product liability the view was held that it was not sufficient to begin the practical implementation (i.e. adherence to the standards) at the time the ISO 26262 is finally published; according to this view the phase between the publication of the DIS and the publication of the final ISO 26262 should be seen as a introduction phase so that manufacturers should begin to adhere to the DIS/ISO 26262 already when the DIS was published in 2009.[44]

Since product liability claims are based on national law, national courts decide on these cases. In the context of a defect of the product German jurisdiction distinguishes between three categories of defects: Faults in construction, faults in fabrication and faults in instruction.[45]

Faults in construction make the product inapplicable for a riskless use and adhere to the whole production run; they are based on an infringement of technical findings during the construction.[46] It is not only the Vienna Convention but also the RESPONSE 3 Code of Practice which points out the basic idea of "controllability". Moreover, FDIS ISO 26262-3 deals with the estimation of controllability during the concept phase (section 7.4.5.4). With regard to the fulfilment of the manufacturer's constructional obligations it is recommendable for the manufacturer, from a product liability point of view, to adhere to the requirements of the RESPONSE 3 Code of Practice and of the FDIS/ISO 26262.

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[39] Palandt/Sprau, sec. 3 ProdHaftG, recital 4

[40] Palandt/Sprau, sec. 3 ProdHaftG, recital 4

[41] Knapp / Neumann / Brockmann / Walz / Winkle (contact persons for the German adaptation); RESPONSE 3: Code of Practice for the Design and Evaluation of ADAS

[42] Duisberg/Appt, p. 215

[43] see Duisberg/Appt, p. 216

[44] Sauler/Kriso, ISO 26262

[45] see Bewersdorf, p. 139

[46] Palandt/Sprau, sec. 3 ProdHaftG, recital 8

As a consequence, it seems – in terms of "controllability" – sensible to provide a technical possibility for the driver to override functions which intervene autonomously any time he wishes to do so.

Faults in instruction belong to the term „presentation" in sec. 3 (1) ProdHaftG (see Art. 6 of the Directive); they consist in an insufficient instruction manual and / or insufficient warnings of dangerous qualities; the producer has got to point out the correct handling and certain dangers possibly occurring.[47] The instructions´ content and coverage has to be orientated to the most endangered user group; it has to include the intended use, but also the obvious use in terms of an accidental misuse and the obvious misuse.[48] Risks resulting from a deliberate or very airy misuse do not have to be included; common know-how does not have to be included in an instruction manual or in a warning.[49]

From a product liability point of view it turns out to be recommendable to instruct the user comprehensively by an instruction manual which emphasizes systems boundaries (for example because of dirt-covered sensors, certain weather conditions etc.) and warns the user of blind trust in the system. Moreover, it is recommendable not to evoke exaggerated expectations concerning product safety by the product's presentation, i.e. advertising effort.

The category of fault in fabrication does not have to be commented further because it is evident that the manufacturer can be held liable for faults in fabrication which arise in the production process. Those faults are present only with the single product and represent a deviation of the concrete piece from the general standard the manufacturer has given for the whole production run.[50]

Product liability has been harmonized on the one hand but still comprises certain differences in the individual EU Member States on the other hand; product liability law still is based on binding national law, i.e. on the different EU Member States´ legal systems. This leads to the question which national product liability law may be applicable with regard to international product liability cases. The answer can be found in Art. 5 of the EU Regulation 864/2007[51] on the law applicable to non-contractual obligations (Rome II) which is applicable since January 2009; it says:

1. *Without prejudice to Article 4(2), the law applicable to a non-contractual obligation arising out of damage caused by a product shall be:*
   (a) the law of the country in which the person sustaining the damage had his or her habitual residence when the damage occurred, if the product was marketed in that country; or, failing that,
   (b) the law of the country in which the product was acquired, if the product was marketed in that country; or, failing that,
   (c) the law of the country in which the damage occurred, if the product was marketed in that country.
   However, the law applicable shall be the law of the country in which the person claimed to be liable is habitually resident if he or she could not reasonably foresee the marketing of the product, or a product of the same type, in the country the law of which is applicable under (a), (b) or (c).

[47] Palandt/Sprau, sec. 3 ProdHaftG, recital 10

[48] Palandt/Sprau, sec. 3 ProdHaftG, recital 11

[49] Palandt/Sprau, sec. 3 ProdHaftG, recital 11

[50] Palandt/Sprau, sec. 3 ProdHaftG, recital 9

[51] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:199:0040:0040:EN:PDF

2. *Where it is clear from all the circumstances of the case that the tort/delict is manifestly more closely connected with a country other than that indicated in paragraph 1, the law of that other country shall apply. A manifestly closer connection with another country might be based in particular on a pre-existing relationship between the parties, such as a contract, that is closely connected with the tort/delict in question."*

Moreover, Art. 14 of Regulation 864/2007 allows for the contractual parties´ freedom of choice concerning the applicable law (in extracts: *"The parties may agree to submit non-contractual obligations to the law of their choice: (a) by an agreement entered into after the event giving rise to the damage occurred; or (b) where all the parties are pursuing a commercial activity, also by an agreement freely negotiated before the event giving rise to the damage occurred."*) In other words: The choice of law cannot be agreed upon with consumers ex ante.[52]

5.2.2 Contractual liability – Directive 1999/44/EC

Due to the above mentioned Art. 13 of the Product Liability Directive, contract law may provide another basis for product liability claims. Contract law and contractual liability in terms of product liability are based on the individual legal systems of the EU Member States. In almost all EU Member States the law of contract will come to the aid of a customer who is injured by a product if the injury results from a breach by the seller of an agreement with the consumer.[53]

With regard to consumer goods contract law has been harmonized up to a certain degree within the EU due to the Directive 1999/34/EC[54] on certain aspects of the sale of consumer goods and associated guarantees.

The Directive 1999/34/EC addresses sale contracts concerning consumer goods between sellers and consumers and defines certain minimum standards concerning liability for consumer goods: the limitation period for contractual liability claims shall not expire within a period of two years from the time of delivery (Art. 5 (1)). Moreover, any lack of conformity which becomes apparent within six months of delivery shall generally be presumed to have existed at the time of delivery (Art. 5 (3)). Furthermore, the Directive constitutes certain requirements concerning guarantees (see Art. 6). Art. 3 (1) of Directive 1999/34/EC postulates that the seller shall be liable to the consumer for any lack of conformity (with the contract of sale) existing at the time the goods were delivered. Art. 4 of Directive 1999/34/EC constitutes the Member States' obligation to provide for the final seller's right of redress against the persons liable in the contractual chain if the final seller is liable to the consumer because of a lack of conformity resulting from an act or an omission by the producer, a previous seller in the same chain of contracts or any other intermediary. It is important to emphasize that the directive does not provide for the direct liability of producers.

Art. 12 of Directive 1999/34/EC obliged the Commission to give a report on the application of the Directive to the European Parliament and the European Council. This report should also, inter alia, examine the case for introducing the producer's direct liability. The final version of this report COM (2007) 210 is dated April 2007. It states that all Member States have transposed Directive 1999/44/EC into national law (for the details see: COMMUNICATION FROM THE COMMISSION TO THE COUNCIL AND THE EUROPEAN PARLIAMENT on the

[52] see Wagner in Münchener Kommentar, Einl. ProdHaftG, recital 24

[53] Lovells, p. 16

[54] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:1999:171:0012:0016:EN:PDF

implementation of Directive 1999/44/EC of the European Parliament and of the Council of 25 May 1999 on certain aspects of the sale of consumer goods and associated guarantees including analysis of the case for introducing direct producers' liability).[55] Concerning the introduction of the producer's direct liability the Commission states that Belgium, Finland, Latvia, Portugal, Spain, Sweden and France have introduced various forms of direct producer's liability (showing considerably varying conditions for making direct claims against producers).[56] The Commission concludes in its report that there is not enough evidence to determine whether the lack of EU rules on direct producer's liability has a negative effect on consumer confidence in the internal market so that the Commission decided not to submit any proposal concerning the introduction of a direct producer's liability.[57]

The importance of contractual liability in terms of product liability differs within the individual EU Member States. It is the basic premise of all contractual systems that the rights and responsibilities of parties to a contract are governed by the terms of that contract and that – generally speaking – third parties do not enjoy any benefits under that contract.[58] Usually, the buyer of a car signs a contract with a dealer / seller, not with the manufacturer of a car or with the manufacturer of a driver assistance system installed in the purchased car. So generally there is no contractual relationship between the buyer or the user of the car on the one hand and the manufacturer of the car on the other hand. As a result, in these cases no contractual liability claims of the buyer / user of a car against the manufacturer are at hand, of course.

However, this so-called privity of contract is not entirely homogenous in the EU Member States.[59] In Germany, for instance, only very few cases of a deviation of this principle can be identified (contracts for the benefit of other persons [sec. 328 BGB {German Civil Law Code}] – and contracts with a protective effect for the benefit of other persons [developed by German jurisdiction]); however, these deviations do not apply to cases of product liability. On the contrary, it is a characteristic that according to German law contracts imposing a burden on a third party are void in general.[60] In France (similarly in Luxemburg) however, the Civil Code incorporates a "latent defects warranty" as well as a general safety duty into the contracts for the sale of goods, the benefit of which passes to successive purchasers of the product.[61]

This description of national specifics concerning contractual liability in the EU Member States could be continued but is necessarily non-exhaustive in the context of WP 77. In summary, it can be stated that generally a uniform contractual law is not at hand in the individual EU Member States. But – concerning consumer goods – a certain degree of harmonization has been established with regard to contract law due to the Directive 1999/44/EC (limitation period at least 2 years from time of delivery, shift of burden of prove for a period of six months from delivery for the benefit of the consumer, requirements concerning guarantees).

Finally, it should not be disregarded that the scope of product liability in terms of the Product Liability Directive (85/374/EEC) and product liability in terms of contractual liability (Directive 1999/44/EC) differs: Contractual liability claims generally provide claims for the contractual

[55] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2007:0210:FIN:EN:PDF

[56] Commission of the European Communities COM (2007) 210 final, p. 11

[57] Commission of the European Communities COM (2007) 210 final, p. 13

[58] Lovells, p. 16

[59] details: see Lovells, p. 16 ff.

[60] see Palandt-Grüneberg, introduction to sec. 328 BGB, recital 10

[61] see Lovells, p. 16

parties whereas product liability claims in terms of the Product Liability Directive do not require a contractual relationship between the claimant and the opponent.

It might be a matter of continuative research to investigate and compare the contractual liability in terms of product liability in the individual Member States based on their contractual law systems.

5.2.3 Extra-contractual liability – law of torts

Moreover, in cases of product liability, the law of torts might provide a basis of claim for persons the damage was inflicted on by a defective product. The law of torts in terms of extra-contractual liability is not based on a common legal framework on EU-level. As with contract law, important differences between the tort laws of the individual EU Member States can be identified, such as the requirement of fault and/or the burden of proof.[62] Every EU Member State provides a system of extra-contractual liability including liability for damages caused by defective products; many legal systems of the EU Member States postulate some element of fault (e.g. negligence) on the part of the manufacturer.[63]

In most of the EU Member States tort law requires the defendant to be at fault or in breach of some general duty to the claimant ("unlawfulness" / "culpability" / "breach of a duty of care").[64] On the other hand, some EU Member States have traditional tort systems under which in some cases proof of fault is not a necessary element – so that it could be described as a kind of "strict liability" (e.g. in France).[65] The legal systems in the individual EU Member States share a common general rule: The claimant bears the onus of proving the essential elements of the case in order to recover compensation; however, in some EU Member States the burden of proof was shifted by jurisdiction especially relating to the necessary element of fault.[66] The presence of an element of fault may be difficult for the plaintiff to prove as especially production is a complex and well-screened process.

In Germany for example, the Supreme Court (Bundesgerichtshof) established a distinctive concept of "producer liability" under tort law (sec. 823 (1) of the German Civil Law Code [BGB]).[67] The shift of the burden of proof takes an important part in this context: if the claimant can prove the existence of a defect of the product, it will (rebuttabely) be presumed that the manufacturer infringed his objective duty of care and did so at fault. Putting a defective product into circulation is the crucial condition of entitlement; additionally a causation between the product's defect and the damage is required; the infringement of the manufacturer's legal duty to maintain safety constitutes the illegality required by sec. 823 (1) BGB. The producer's fault required by sec. 823 (1) BGB consists in an at least negligent infringement of the producer's legal duty to maintain safety by putting a defective product into circulation. In the context of sec. 823 (1) BGB the manufacturer must adhere to the identifiable and determinable state-of-the-art of science and technology as far as construction, production (fabrication) and instruction are concerned.[68] In practice, this tortious liability based on sec. 823 (1) BGB has become more and more similar to a strict liability

[62] see Lovells, p. 19

[63] see Lovells, p. 10

[64] see Lovells, p. 19

[65] see Lovells, p. 19

[66] see Lovells, p. 19

[67] first in the „chicken-pest"-case in 1968 [BGH VI ZR 212/66], see Lovells p. 19

[68] Palandt/Sprau, sec. 823 BGB, recital 169

because generally German jurisdiction assumes a culpable conduct, i.e. a fault of the producer if the other conditions of sec. 823 (1) BGB are fulfilled (shifting of the burden of proof).

This portrayal of national characteristics with regard to tortious liability in the EU Member States could be perpetuated. However, within the scope of WP 77 the focus lies on the legal framework on EU-level. Summarizing, there is neither a uniform tort law nor a uniform tort liability available in the individual legal systems of the EU Member States. Extra-contractual liability in terms of product liability is – besides national laws deriving from the Product Liability Directive 85/374/EEC (see above) – not based on a common legal framework on EU-level.

Therefore, extra-contractual liability claims concerning product liability cannot be based on a common tort liability system framework on EU-level or on homogeneous national laws of torts basing on a common ground such as an EU Directive. It might be a matter of continuative research to investigate and compare the individual Member States´ tort liability systems with particular regard to product liability claims.

5.2.4 Other liability systems

Art. 13 of the above mentioned Product Liability Directive 85/374/EEC not only preserves the traditional liability systems based on contract and tort, but also any "special liability system existing" at the moment when the Directive was notified. An important example for this can be found in Germany: Sec. 15 (1) ProdHaftG mentions the German Drug Act (Arzneimittelgesetz). The German Drug Act contains particular provisions concerning causation and excludes the development risk defence.[69] Another example is the German Genetic Engineering Act (Gentechnikgesetz) which – inter alia – provides (in sec. 37 (2)) an intensification of liability arising from products containing genetically manipulated organisms.[70] Other "special liability systems" in terms of Art. 13 of the Product Liability Directive may vary from Member State to Member State so that no uniform or homogeneous special liability system in terms of product liability on EU-level is identifiable.

5.2.5 Summary – product liability

The general findings concerning product liability on EU-level can be summarized as follows: Relevant provisions concerning product liability can be found in the Product Liability Directive 85/374/EEC and the corresponding individual EU Member States´ laws which implemented the Directive into national law. With regard to the liability deriving from those sources of law a product should comply with the state-of-the-art in science and technology – in order to be able to prove that this state-of-art was adhered to during the design, the construction and the production processes and with that in order to reduce product liability risks, relevant systems of rules like the RESPONSE 3 Code of Practice respectively technical standards like the FDIS/ISO 26262 should be observed. From a product liability point of view it is recommendable to design the functions developed in the interactIVe-project in a way allowing the driver to override automated braking and/or steering interventions any time the driver wishes to do so.

[69] see Lovells, p. 21

[70] Palandt/Sprau, sec. 15 ProdHaftG recital 1

5.3 Product Safety Law: General Product Safety Directive 2001/95/EC

In the context of a future market introduction of the functions developed within the interactIVe project, Product Safety Law should not be disregarded. On EU-level, it is based on the General Product Safety Directive (GPSD) 2001/95/EC. Art. 2 GPSD defines terms like "product", "safe product", "dangerous product", "recall" and "withdrawal" for the purposes of the GPSD. Art. 3 (1) GPSD postulates that producers shall be obliged to place only safe products on the market. Consequently, Art. 8 (1) (f) GPSD obliges the EU Member States – inter alia – to entitle competent authorities to take measures for any product, especially for any dangerous product (e.g. to ban its marketing and introduce the accompanying measures required to ensure the ban is complied with; or for any dangerous product already on the market to order or organise its actual and immediate withdrawal, and alert consumers to the risks it presents; to order or coordinate or, if appropriate, to organize together with producers and distributors its recall from consumers and its destruction in suitable conditions). Due to its character as a directive the GPSD had to be transposed into national law by the individual EU Member States. In Germany for example the GPSD was transposed into national law in 2004 by the Equipment and Product Safety Act (Geräte- und Produktsicherheitsgesetz) which contains in its sec. 8 (4) the measures that can be taken by the competent authorities (as postulated by Art. 9 (1) GPSD). Moreover, the German Equipment and Product Safety Act postulates in its sec. 4 (4) (2) that generally a manual in German language has to be supplied for any "ready-to-use" object of utility. With regard to Regulation (EC) 765/2008 (setting out the requirements for accreditation and market surveillance relating to the marketing of products) the German Equipment and Product Safety Act is currently being revised. The current draft – which will presumably also bring about a change of the Act's name to "Produktsicherheitsgesetz" (Product Safety Act) – stipulates, which is new, a fine (up to 10.000,- EUR) in case a manual is not, not accurately, not completely, not timely or not correctly provided when a product is placed on the market.

Because of the GPSD's character as a directive, the law and rules binding the individual respectively the producer of a product can be found on national level. Concerning the functions developed within the interactIVe-project and a future market introduction, it should be kept in mind that a comprehensive and comprehensible manual respectively instruction is not only crucial with regard to Product Liability Law, but also with regard to Product Safety Law.

5.4 Data Privacy / Security – V2V/V2X included in particular functions

Some of the functions developed in the project can include V2V- respectively V2X-communication (such as enhanced Dynamic Pass Predictor (eDPP) or Continuous Support (CS)). This implies that data is exchanged between cars equipped with the corresponding functions as well as between equipped cars and corresponding infrastructure. This data exchange might raise questions with regard to privacy and security aspects.

On EU-level, data privacy and security aspects are addressed by the Directives 95/46/EC (Data Protection Directive)[71] and 2002/58/EC (Directive on Privacy and Electronic Communications)[72]. As far as V2V- respectively V2X-elements are included in the functions this could – from a technical point of view – be based on different technologies such as mobile cellular communications or WLAN. In context with the CS function V2X-communication could contribute to be able to the detection of a crossing vehicle in advance. With regard to the eDPP function V2V-communication could contribute to gain additional information on the oncoming vehicle. The information respectively the data exchanged via

[71] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31995L0046:en:HTML

[72] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2002:201:0037:0047:EN:PDF

V2V- respectively V2X-communication might include data like the location of the vehicle (and with that the location of the person driving the vehicle) or the speed of the vehicle (and with that the speed the person driving the vehicle probably chose). This information respectively this data could be seen as personal data in terms of data privacy and security.

The Directive 95/46/EC describes minimum standards for the protection of data which all EU Member States have to adhere to by implementing corresponding national laws. Art. 2 of the Data Protection Directive (95/46/EC) defines – inter alia – what the terms "personal data", "processing of personal data" and "the data subject's consent" shall mean for the purposes of this Directive. Art. 7 of Directive 95/46/EC obliges the EU Member States to provide that personal data may be processed only on the premise that the data subject has unambiguously given his or her consent or that processing is necessary for the purposes listed in Art. 7 of Directive 95/47/EC.

The Directive 2002/58/EC completes the Directive 95/46/EC with regard to the area of telecommunication. Art. 2 of the Directive on Privacy and Electronic Communications (2002/58/EC) refers to the definitions of Directive 95/46/EC and declares those definitions to be applicable for the purposes of Directive 2002/58/EC. Moreover, Art. 2 of Directive 2002/58/EC contains additional definitions, such as – inter alia – definitions for the terms "location data", "user" and "consent". Art. 4 of Directive 2002/58/EC addresses security and in connection with that addresses providers of publicly available electronic communications services and providers of public communications networks. Art. 9 of Directive 2002/58/EC deals with location data other than traffic data (traffic in the sense of data traffic, not road traffic) – traffic data in the sense of the Directive means any data processed for the purpose of the conveyance of a communication on an electronic communications network or for the billing thereof (see Art. 2 (b) of Directive 2002/58/EC). Since the location of a vehicle may represent most important data in the context of the V2V-/V2X-elements in the interactIVe-project´s functions, Art. 9 of Directive 2002/58/EC should not be disregarded, it says [in extracts]:

> "*Where location data other than traffic data, relating to users or subscribers of public communications networks or publicly available electronic communications services, can be processed, such data may only be processed when they are made anonymous, or with the consent of the users or subscribers to the extent and for the duration necessary for the provision of a value added service. The service provider must inform the users or subscribers, prior to obtaining their consent, of the type of location data other than traffic data which will be processed, of the purposes and duration of the processing and whether the data will be transmitted to a third party for the purpose of providing the value added service. Users or subscribers shall be given the possibility to withdraw their consent for the processing of location data other than traffic data at any time.*
>
> *[…] the user or subscriber must continue to have the possibility, using a simple means and free of charge, of temporarily refusing the processing of such data for each connection to the network or for each transmission of a communication […]*"

The provisions quoted above make clear that processing location data in the context of V2V-/V2X-communication may require the user's, i.e. the driver's or possibly the vehicle's registered keeper's or possibly the vehicle owner's consent. This may depend on how the V2V-/V2X-communication is designed and it mainly depends on the Member States' national law which transposed the EU Directives 95/46/EC and 2002/58/EC into the individual Member States' legal systems. Due to its legal character as a Directive the Product Liability Directive had to be transferred into binding national law by the individual EU Member States. In Germany for instance the corresponding provisions can be found in the Federal Data

Protection Act (Bundesdatenschutzgesetz) and in the Telecommunication Act (Telekommunikationsgesetz).

Since the majority of functions developed within the interactIVe-project do not include any V2V-/V2X-elements and since the information about the technical realization of the V2V-/V2X-elements which is available at the time this Deliverable 7.3 is being written is rather limited, the view on data privacy and security aspects cannot be more detailed at this point, particularly as the focus of WP 77 is on regulations and directives affected on EU-level, not on national level.

But it can be concluded that – as far as V2V- respectively V2X-communication is included in the functions developed within the interactIVe-project – it seems recommendable to make the processed data anonymous respectively to make sure the user, i.e. the driver gives his or her consent prior to collecting respectively processing data as far as such data is concerned which could be qualified as personal data in terms of the above mentioned EU Directives 95/46/EC and 2002/58/EC.

5.5 Legal framework's impact on the interactIVe functions

Concerning the impact of the legal framework on the functions which are being developed in the interactIVe project, potential barriers can be identified more easily by considering a possible unintended behaviour of the functions (due to malfunctions or system boundaries): On the one hand unwanted activations of the function are imaginable; on the other hand failures in activation might occur, i.e. desirable interventions respectively warnings are omitted.

5.5.1 Distinction of the functions

From a legal point of view it is essential to consider the functions developed within the interactIVe-project in several regards; it may – depending on the individual function – be relevant to consider if a function

- provides for interventions (braking and/or steering) or for mere information / warning;
- provides for overrideable interventions or for non-overrideable interventions;
- provides for interventions in time-critical situations or for a kind of continuous support;
- provides for interventions in time-critical situations when a collision is unavoidable or for interventions at an earlier stage.

Concerning interventions an intervention by means of a braking actuator aiming at changing the lateral movement of the vehicle could be qualified as a steering intervention from a legal point of view since such an actuation intervenes in the process of steering the vehicle into the direction chosen by the driver. In contrast, such an actuation could at the same time be qualified as a braking intervention from a technical point of view (see above chapter 3.3, page 25).

As already mentioned above it is crucial to distinguish between intervening functions on the one hand and information / warning functions on the other hand and to distinguish between overrideable and non-overrideable interventions. Consequently, the order in which the functions are portrayed in the following in the legal context is geared to the "intensity" of the intervention provided for by the individual function.

5.5.2 INCA: RECA – Braking intervention non-overrideable / Steering intervention overrideable

The RECA (Rear End Collision Avoidance) function provides for warnings and for automated braking and/or steering interventions aiming at avoiding rear end collisions. The braking interventions provided by the RECA function are non-overrideable in case the collision is unavoidable for the driver. The reason for the non-overrideability of braking interventions shall be to avoid that the driver might panic and press the accelerator accidentally. In this context, the legal framework and especially product liability risks concerning automated interventions is presented in detail. Potential product liability risks resulting from warning functions are commented at another point in this document (see the remarks concerning the eDPP function).

Referring to automated interventions the view might be held that the RECA function is non-compliant with the driver's will because of the fact that the driver does not necessarily express his will explicitly to be supported by an automated intervention in a critical situation so that it could be assumed that the RECA function runs contrary to Articles 8 (1), (5) and 13 (5) of the Vienna Convention. The RECA function is intended to initiate non-overrideable automated braking interventions in a situation in which the driver cannot avoid the collision by himself any more. It may be assumed that it complies with the will of a carefully acting driver to avoid or mitigate a collision. Moreover, it may be assumed that it complies with the driver's presumable will to mitigate an unavoidable collision. The RECA function initiates non-overrideable automated braking interventions in such situations in which the driver himself is no longer able to choose an alternative option to act, i.e. in pre-crash phases of unavoidable accidents. So in that respect controllability in terms of the Vienna Convention is not affected in a way that would run contrary to the Vienna Convention.

The fact that the RECA function provides for such automated braking interventions which cannot be overridden by the driver could lead to an increased product liability risk. From a product liability point of view two relevant scenarios have to be taken into consideration in this context:

On the one hand it seems imaginable that accidental, i.e. unwanted activations of braking and/or steering interventions might occur even though there actually is no collision impending (e.g. due to a detection sensor's malfunction). The driver might want to override the ongoing intervention in order to avoid a rear end collision with the vehicle behind his own but fails to do so because the function does not provide for the possibility to override an intervention and that due to this unwanted, non-overrideable intervention a collision with another road user occurs.

On the other hand it is imaginable that the RECA function fails to intervene, i.e. a braking and/or steering intervention which could have mitigated or avoided the crash is omitted by the RECA function so that a collision with another road user occurs.

Considering the first scenario (false-positive intervention) from a product liability point of view, national jurisdictions might consider it to be a fault in construction or a fault in instruction if an automated intervention cannot be overridden by the driver. According to Article 6 of the Product Liability Directive (84/374/EEC) a product is defective when it does not provide the safety which a person is entitled to expect, taking all circumstances into account: the presentation of the product, the use to which it could reasonably be expected that the product would be put and the time when the product was put into circulation. According to German jurisdiction (referring to the German Product Liability Act which transferred the Product Liability Directive into German law) the product must comply with the

state-of-the-art of science and technology.[73] The RESPONSE 3 Code of Practice (CoP) is perceived as a code of practice representing the state-of-the-art of science and technology.[74] Controllability is a crucial principle of the CoP.[75] Moreover the CoP also refers to the Vienna Convention: *"Due to the system limits of environmental sensing systems, the usage of the assistance functionality will also be limited. This implies that a direct interaction between the driver and the system is necessary. This interaction has to be controllable also with regard to current legislation (Vienna Convention)."*[76] According to the CoP controllability is – inter alia – dependent on the driver's capability to decide on appropriate countermeasures (e.g. override, system switch-off).[77]

Consequently, controllability takes an important part in terms of product liability: It turns out to be vital that the driver can override and with that correct falsely triggered automated interventions. Moreover, in case of a false-positive intervention (e.g. falsely triggered automated braking and/or steering intervention) controllability concerning this fault seems more probable if the activation of the intervention is preceded by a strategy aiming at warning the driver informing him of an upcoming intervention: If the driver is informed respectively warned before an intervention occurs, this might provide respectively increase the opportunity for the driver to override the automated intervention and with that to avoid a collision caused by a falsely triggered automated intervention. In this respect the RECA function complies with the recommendations concerning product liability since it is intended to provide the respective warnings for the driver.

On the other hand, regarding the false-positive intervention, the design of the RECA function could be regarded as faulty in terms of product liability (fault in construction) because the RECA function might initiate a braking and/or steering intervention which is not justified by a real risk: if the facts in the scenario describing the false-positive intervention were taken to a German court, the court could possibly assume a fault in construction and with that assume a case of product liability.

Art. 6 of the Product Liability Directive ("*A product is defective when it does not provide the safety which a person is entitled to expect, taking all circumstances into account […]*") requires to define user expectations not only from the personal perspective of the user but by taking all other indications relevant for the determination of what is hence to be considered a "defect" into account. At this point, the specific situation for automated emergency braking/steering interventions must be considered: This technology cannot be considered sufficiently common to determine reasonable user expectations on a widespread basis today. Yet, present system design will contribute immensely to tomorrow´s reasonable user expectations as far as the respective product safety is concerned. At this point the close link of product safety with the driver's task must be considered: Product safety in this respect can substantially be determined by the ability of the driver to cooperate with the system in case of an intervention. This is certainly very limited in emergency situations. On the other hand, in case of false-positive interventions, the consequences can very well be influenced by the counteracting driver. This, however, presupposes the possibility of the driver to override/oversteer. Therefore the mere possibility to override can substantially minimise the manufacturers risk not only in the single case but also by influencing overall user expectations in terms of safe system use. The latter can additionally contribute to a reduction

[73] Palandt/Sprau, sec. 3 ProdHaftG recital 4

[74] Gasser, Legal Aspects of Driver Assistance Systems, pp. 815-828

[75] see also Gasser, Legal Aspects of Driver Assistance Systems, pp. 815-828

[76] Knapp / Neumann / Brockmann / Walz / Winkle (contact persons for the German adaptation); RESPONSE 3: Code of Practice for the Design and Evaluation of ADAS, p. 2

[77] Knapp / Neumann / Brockmann / Walz / Winkle (contact persons for the German adaptation); RESPONSE 3: Code of Practice for the Design and Evaluation of ADAS, p. 13

of the product liability risk taken by the manufacturer. Moreover, it will influence user expectations in so far as their influence on safely exercised "use" would be maintained. Concerning user expectations in the context of product liability, it should not be disregarded that results of studies examining driver behaviour during autonomous emergency braking manoeuvres already have been published.[78] These studies are reported to have shown, inter alia, the result that the test-persons expected overrideability of autonomous emergency braking manoeuvres, especially by pressing the accelerator pedal.[79]

Furthermore, it would be a matter of the design of the RECA function in which cases it intervenes and if it possibly should be designed in a way that it does not initiate an intervention under certain circumstances despite (possibly faulty) obstacle detection by the sensors. This might reduce the number of possible accidental deployments and by doing so reduce the product liability risk.

Regarding the second scenario described above referring to the omission of a desirable intervention it is crucial – with regard to product liability – to instruct the user, i.e. the driver, in a comprehensive and comprehensible way. That means that system boundaries and possible malfunctions as well as foreseeable incorrect use should be pointed out (e.g. in the manual) and that no exaggerated expectations (e.g. by the product's presentation or by advertising effort) concerning the function's capabilities should be raised. Moreover, the user should be warned of blind trust in the function. The assumption of a fault in construction in this scenario is improbable, because under certain circumstances (system boundaries) the RECA function can necessarily not work properly. Nevertheless, it might be considered as a fault in instruction if the user was not sufficiently notified of system boundaries or possible system failures for instance. A product liability case in this context is improbable if the producer can prove to have informed the user sufficiently about system functions and boundaries, because this decreases the probability of the assumption of a fault in instruction.

Concerning the RECA function, the following recommendations can be summarized from a product liability point of view:

- As far as the RECA function is designed in a way that prevents the driver from overriding braking interventions, this might possibly be seen as a defect of the product by jurisdiction, i.e. by national courts, since it is not only the Vienna Convention but also the RESPONSE 3 Code of Practice which points out the basic idea of "controllability". With regard to the fulfilment of the manufacturer's constructional obligations resulting from product liability it is recommendable for the manufacturer to adhere to the requirements of the RESPONSE 3 Code of Practice. As a consequence, it seems – in terms of "controllability" and for the purpose of decreasing product liability risks (in case of false-positive interventions) – sensible to provide a technical possibility for the driver to override automated interventions.
- The driver should be informed respectively warned of impending automated interventions.
- The driver should be instructed in a comprehensive and comprehensible way about the function, its boundaries, possible malfunctions and the substantial risk of blind trust.

Conclusion:	Critical with regard to product liability risks and Vienna Convention due to non-overrideable braking interventions

[78] Kobiela / Engeln, ATZ 2010, 702 ff.

[79] Kobiela / Engeln, ATZ 2010, 702 (705, 706)

5.5.3 EMIC: CMS – Braking and steering intervention overrideable

The scope of the CMS (Collision Mitigation system) and the RECA function is quite similar since a collision shall be mitigated respectively avoided by means of automated braking and/or steering interventions. Consequently, the legal findings for these functions are quite similar. The CMS provides for warnings and automated braking and/or steering interventions aiming at reducing the impact speed and optimizing the crash collision constellation. In contrast to the RECA function, the automated interventions by the CMS are all overrideable.

Since the automated steering interventions shall be designed in a way allowing for overriding this design complies with what is recommendable from a product liability point of view.

Besides that, the intended design of the CMS raises questions in the following respect: The CMS shall provide for steering interventions aiming at optimizing crash collision vectors. This makes it seem imaginable that the damage and the injuries for the driver and the passengers of the CMS-equipped vehicle might be reduced because of the CMS intervention whereas the damage and the injuries for the driver and the passengers of the opponent vehicle might be increased. In case of a collision causing bodily injury the driver respectively the keeper of a CMS-equipped vehicle might possibly have to face the reproach that he used a CMS-equipped vehicle being aware of the fact that it could cause or at least increase the degree of bodily injury for the opponent vehicle's occupants. It is arguable and presently not foreseeable if and in how far national jurisdictions might regard this awareness of the driver – in case of bodily injuries of other persons – as an element contributing to a higher degree of negligence assigned to the driver concerning civil (indemnity claims) or a criminal (bodily injury) liability of the driver or the registered keeper of the vehicle. Beyond that, regarding product liability, it seems recommendable to choose a system design which does not contribute to an increase of the opponent vehicle's occupants´ bodily injury.

Conclusion:	No particular risk provided the product liability risk is addressed appropriately (and provided that non-overrideable interventions are not included in the CMS)

5.5.4 INCA: OVCA – Braking intervention overrideable / No steering intervention

The OVCA (Oncoming Vehicle Collision Avoidance/Mitigation) function is designed to prevent collisions with oncoming vehicles. In contrast to the RECA function the OVCA function provides for overrideable automated braking interventions. Steering interventions do not seem to be part of the OVCA function by the time this deliverable is being written.

In case the OVCA function eventually will include any non-overrideable steering interventions the legal findings concerning the OVCA function will be similar to those concerning the RECA function respectively the CMS with regard to the non-overrideability of the interventions.

In case V2V-communication will be included in the OVCA function, it is – from a data privacy point of view – recommendable to make the processed data anonymous respectively to make sure that the person using the vehicle and with that the OVCA function gives his/her consent to collecting or processing data prior to using the OVCA function as far as these data could be qualified as personal data in terms of data privacy.

Conclusion:	No particular risk provided the product liability risk is addressed appropriately (and provided that non-overrideable interventions are not included in the OVCA function)

5.5.5 EMIC: ESA – No braking intervention / Steering intervention overrideable

The ESA (Emergency Steer Assist) function is designed to support the driver in critical situations by applying additional steering torque. Those steering interventions are designed to be overrideable by the driver.

The product liability risk arising from the ESA function in case of false-positive interventions and in case of failures to intervene can be compared to the product liability risk arising from functions providing for overrideable emergency braking interventions. Since the additional steering torque and with that the steering intervention is designed to be overrideable the driver still should be able to counteract a false-positive intervention or an intervention which is non-compliant with his will.

Conclusion: No particular risk provided the product liability risk is addressed appropriately

5.5.6 INCA: LCCA – Braking and steering intervention overrideable

The LCCA (Lane Change Collision Avoidance) function is intended to prevent collisions during intended or unintended lane changes by automated braking and/or steering interventions.

The two cases considered in the context of the CMS (including intervening functions not providing for overriding) above – false-positive intervention and failure to intervene – can also serve to illustrate the impact of the legal framework with regard to intervening functions which do provide for overriding.

Regarding the LCCA function the product liability risk coinciding with a false-positive intervention is considerably lower than it is for non-overrideable interventions: Since the LCCA function gives the driver the technical opportunity to override automated braking interventions as well as automated steering interventions, the probability that the driver is able to override a possible false-positive intervention and by doing so to avoid a collision is increased. The technical opportunity to oversteer may lead to an increase of the driver's responsibility on the one hand, but may, on the other hand, reduce the manufacturer's product liability risk to some extent as well.

Concerning the omission of a desirable intervention that might have avoided or mitigated a collision it is – as already stated above concerning the CMS – crucial to instruct the user, i.e. the driver, in a comprehensive and comprehensible way in order to reduce the product liability risk.

Conclusion: No particular risk provided the product liability risk is addressed appropriately

5.5.7 INCA: SIA – No braking intervention / Steering intervention overrideable

The SIA (Side Impact Avoidance) function is designed to prevent sideswipe accidents. It does not provide for any braking interventions but for warnings and overrideable steering interventions.

With regard to the steering interventions in the SIA function the remarks concerning product liability in the LCCA function can be referred to since the steering interventions in the SIA function are overrideable, too.

Conclusion:	No particular risk provided the product liability risk is addressed appropriately

5.5.8 INCA: RORP – No braking intervention / Steering intervention overrideable

The RORP (Run Off Road Prevention) function shall prevent run off road accidents by warnings and automated steering interventions which shall be overrideable by the driver. The steering interventions take place in an area when a road departure is unavoidable.

The remarks concerning functions providing for overrideable interventions can be referred to herewith.

Conclusion:	No particular risk provided the product liability risk is addressed appropriately

5.5.9 INCA: RORP (curve) – Braking intervention overrideable / No steering intervention

The RORP (curve) function is intended to prevent road departures in curves. It provides for information respectively warnings and automated braking interventions which are overrideable by the driver.

The findings referring to functions providing for overrideable interventions can be referred to herewith.

Conclusion:	No particular risk provided the product liability risk is addressed appropriately

5.5.10 SECONDS: CSC – Braking intervention overrideable / No steering intervention

The CSC (Curve Speed Control) function provides for information respectively warnings in case the vehicle is approaching a curve with a too high velocity. In case the vehicle's ACC (Adaptive Cruise Control) is activated in such a situation the CSC function additionally provides for automated braking interventions. In contrast to the RORP (curve) function automated braking intervention are dependent on the status (activated or not activated) of the ACC.

The CSC function might imply a certain danger of wrong use which may go beyond system limits – particularly with regard to the fact that the automated braking interventions are intended to take place in an area in which the driver already has handed over a part of the driving functions to the ACC. In this context, fully informing and warning the driver will be crucial, yet leaving the manufacturer with the risk of overreliance on the side of the driver possibly being considered as a case of reasonably foreseeable misuse in terms of product liability.

Conclusion:	Increased product liability risk to be addressed (due to risk of excessive use by the driver [not intended by the manufacturer])

5.5.11 SECONDS: CS – Braking and steering intervention overrideable

The CS (Continuous Support) function provides for warnings and – as far as the FFA and the VCC demonstrators are concerned – automated braking and/or steering interventions which are designed to be overrideable by the driver. The CS function addresses a rather vast variety of use cases concerning critical driving situations.

With regard to the considerable amount of use cases addressed by the CS function a substantial danger of wrong use in terms of overreliance on the side of the driver might arise – possibly beyond system limits. It will be vital to fully inform and warn the driver. Nevertheless, the manufacturer is left with the risk of overreliance on the side of the driver which might be considered as a case of reasonably foreseeable misuse.

Conclusion:	Increased product liability risk to be addressed (due to risk of excessive use by the driver [not intended by the manufacturer])

5.5.12 SECONDS: SC – Braking and steering intervention overrideable

The SC (Safe Cruise) function is designed to provide for automated vehicle following on extra urban roads which includes overrideable braking and/or steering interventions. This function shall include driver monitoring and surveillance by means of a camera for the purpose of deactivating the automated following if the driver performs secondary tasks excessively. Moreover, the SC function is intended to address, inter alia, the use case “rear end collision” providing for the performance of an automated evasive manoeuvre.

Like in other functions providing for interventions the risk of a false-positive intervention is at hand even though the SC function is being developed according to functional safety requirements: A false-positive intervention in the shape of an automated evasive manoeuvre could lead to a collision with oncoming traffic. The product liability risk arising from this scenario is increased by the fact that this might happen in a situation, in which the driver is performing secondary tasks excessively and in which the SC function fails to detect that the driver is doing so, so that the driver fails to correct i.e. to override the false-positive intervention even though the interventions in the SC function may be designed to be overrideable by the driver.

Moreover, the omission of a desirable intervention, i.e. a desirable automated evasive manoeuvre could lead to an increased product liability risk if this happens in a situation, in which the driver is performing secondary tasks excessively and in which the SC function fails to detect that he is doing so.

The BASt-project group ‘Legal consequences of an increase in vehicle automation’ is going to publish its definitions and legal findings concerning different degrees of automation in the course of 2011. A function like the SC function could be qualified as partly automated in terms of the definitions agreed upon by the project group since the function takes over the longitudinal and the lateral guidance of the vehicle in a specific situation (extra urban roads) while the driver has to monitor the system and has to be ready to take the vehicle guidance back at any time.

Regarding functions that can be qualified as partly automated in terms of the definitions of the BASt-project group, such as the SC function, it is one of the vital tasks of the driver to monitor the system for a considerable period of time while he or she possibly will not have to execute any corrections of the lateral or the longitudinal guidance of the vehicle during that period. This might increase the risk that the driver uses the function in an excessive way which is not intended by the manufacturer. Generally, misuses close to the intended use of the product whose risks are consequently not easily noticeable for a consumer und which can cause damages of a vast extent must give the manufacturer reason to extensive effort.[80] In the context of partly automated driving functions the BASt-project groups’ results and findings should be taken into account once they are published.

[80] Wagner in Münchner Kommentar, sec. 3 ProdHaftG, recital 21

Conclusion:	Increased product liability risk to be addressed (due to risk of excessive use by the driver [not intended by the manufacturer])

5.5.13 SECONDS: eDPP – No braking nor steering intervention

The eDPP (enhanced Dynamic Path Predictor) function provides information about safe overtaking areas and vehicles in the overtaking path to avoid overtaking crashes. The function informs respectively warns the driver but does not provide for any automated braking and/or steering interventions.

With regard to information about safe overtaking areas it might turn out to increase the product liability risk if the eDPP function explicitly informs the driver of a “safe overtaking area” by using even that wording because this might raise the expectation that overtaking is safe as long as the eDPP function does not provide any information / warning speaking against an overtaking manoeuvre. The product liability risk could possibly be decreased if the function warned the driver of the beginning of unsafe overtaking areas without evoking the expectation that overtaking was safe in all the other areas not marked as “unsafe”.

The following remarks concerning warnings also refer to all of the other functions in the interactIVe project (see above) as far as they provide for warnings, but it seemed appropriate to give a detailed legal view on warning functions in the context of the eDPP function since it focuses on information respectively warnings without providing for automated interventions.

Concerning warnings, two relevant cases can be considered: The first scenario is a false-positive warning causing a collision. The second scenario is the failure to provide a warning even though a timely warning would have avoided or at least mitigated the collision. The main difference between the scenarios concerning an automated intervention on the one hand and the cases concerning collision warning on the other hand is the following: Since a mere warning does not intervene in the driving process automatically, the driver can “override” the warning easily by simply ignoring it. The legal findings for the two cases concerning warnings will differ from the findings for the two scenarios concerning the automated interventions in the following respect:

In case of faults in construction, fabrication or instruction the manufacturer will, in terms of product liability, be held liable for damages occurring in the context of a false-positive warning as well as in the context of an omission of a warning. Since a mere warning does not intervene in the driving process and since the driver is able to “override” (ignore) the warning easily at any time, the driver’s behaviour takes an important role in this context: The driver’s degree of contributory negligence leading to a collision may – depending on the national laws of the EU Member States – reduce the manufacturer’s product liability. Moreover, the case could be considered that the driver is frightened by a false-positive warning or by an omitted warning (without subsequent collision because the driver can handle the situation all by himself): According to German law for example, in these cases no relevant liability risk is identifiable since there is no damage. The fact that the driver is merely frightened (without a subsequent collision) may trigger liability risks only if this fright leads to bodily harm, such as a state of shock or a heart attack or something of that kind. As already mentioned in the context of the scenarios concerning automated interventions, from a product liability point of view it is crucial to instruct the user, i.e. the driver, on system boundaries possibly leading to false-positive warnings or possibly leading to absence of warnings in critical situations: The better and the more comprehensively the driver is instructed (especially by the manual), the more he may legitimately be expected to deal with a warning function in an adequate manner. A comprehensive and comprehensible instruction may well contribute to a reduction of the manufacturer’s product liability risk. If the driver is conscious of the fact that a warning may fail to appear or may be false, he may legitimately be expected to “override” the

function, i.e. to ignore the false warning respectively to compensate the absence of a warning by reacting to a critical situation in own responsibility.

In case V2V/V2X-communication should be included in the eDPP function, it is – from a data privacy point of view – recommendable to make the processed data anonymous respectively to make sure that the person using the eDPP-equipped vehicle gives his/her consent to collecting or processing data prior to using the eDPP function as far as these data could be qualified as personal data in terms of data privacy.

Conclusion:	No particular risk provided the product liability risk is addressed appropriately

5.6 Conclusions

The functions developed in the interactIVe project are affected by the existing legal framework on EU-level mainly with regard to product liability (basing on Directive 85/4374/EEC) and – connected with that – with regard to the 1968 Vienna Convention on Road Traffic.

Functions providing for mere information respectively warnings can easily be overridden and hence be controlled by the driver. Functions providing for automated braking and/or steering interventions bring along an increased product liability risk since the driver has to do more than simply ignore a false-positive warning: he/she will have to counteract actively on a false-positive intervention.

Non-overrideability of automated braking and/or steering interventions increases the product liability risk since the driver cannot counteract a false-positive intervention in this case.

The question in how far partly automated functions taking over longitudinal and lateral guidance of the vehicle for a certain period of time or in specific situations might also increase the product liability risk is currently being examined by the BASt-project group ‘Legal consequences of an increase in vehicle automation’ which will present its findings in the course of 2011.

Product liability risks have to be addressed appropriately, also with regard to the Vienna Convention on Road Traffic which constitutes the requirement of controllability.

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Abbreviations

Abbreviation	Description
ABS	Antilock Brake System
ACC	Adaptive Cruise Control
ADAS	Advanced Driver Assistance System
BGB	German Civil Law Code
CAN	Controlled Area Network
CMS	Collision Mitigation System
CS	Continuous Support
CSC	Curve Speed Control
CV	Crossing Vehicle
eDDP	enhanced Dynamic Pass Predictor
EC	European Commission
EMIC	EMergency Intervention for Collision mitigation
ESA	Emergency Steer Assist
ESC/ESP	Electronic Stability Control / Electronic Stability Program
EU	European Union
HMI	Human Machine Interface / Interaction
HV	Host Vehicle
INCA	INtegrated Collision Avoidance and vehicle path control
ISO	International Organization for Standardization
IWI	Information, Warning and Intervention
LCCA	Lane Change Collision Avoidance
LED	Light-emitting diode
LKS	Lane Keeping System
LV	Lead Vehicle
OEM	Original Equipment Manufacturer
OV	Opponent Vehicle
OVCA	Oncoming Vehicle Collision Avoidance/Mitigation
ProdHaftG	Produkthaftungsgesetz (German Product Liability Act)
RECA	Rear End Collision Avoidance
RORP	Run-off Road Prevention
RQ	Research Question
SC	Safe Cruise
SECONDS	Safety Enhancement through CONtinuous Driver Support
SIA	Side Impact Avoidance
SP	Subproject

Abbreviation	Description
StVO	Straßenverkehrsordnung (German Road Traffic Code)
TEC	Treaty establishing the European Community
TFEU	Treaty on the Functioning of the European Union
TTC	Time To Collision
UC	Use Case
VC	Vienna Convention on Road Traffic
V2V	Vehicle to Vehicle
V2I	Vehicle to infrastructure
V2X	Vehicle to X (car and infrastructure)
VRU	Vulnerable Road User

Glossary

Glossary	Description
Aspect	A specific action that is part of a function and / or a system and that is common for different functions / systems. E.g., “automatic steer”.
Component	A device or a set of devices necessary for the implementation of an aspect, function or system. E.g., “perception component”, “logic component”
Function	A task, action, or activity that must be accomplished to achieve a desired outcome. E.g., “lane keeping”
System	A collection of components organized to accomplish a specific function or set of functions. E.g., “EMIC”
Target scenario	The general purpose of the target scenarios in interactIVe is to define the *problem* - in terms of an undesired outcome - that the envisioned interactIVe functions are to address
Test scenario	Scenario where a certain aspect, function or system is tested
Use case	*Use cases* which define *how the problem will be solved*, that is, how the function is intended to prevent the targeted accidents or mitigate their consequences

Annex 1: List of UN ECE regulations under the 1958 agreement

Regulation No.	Title
1	Uniform provisions concerning the approval of motor vehicle headlamps emitting an asymmetrical passing beam and/or a driving beam and equipped with filament lamps of categories R2 and/or HS1
2	Uniform provisions concerning the approval of incandescent electric lamps for headlamps emitting an asymmetrical passing beam or a driving beam or both
3	Uniform provisions concerning the approval of retro-reflecting devices for power-driven vehicles and their trailers
4	Uniform provisions concerning the approval of devices for the illumination of rear registration plates of power-driven vehicles and their trailers
5	Uniform provisions concerning the approval of power-driven vehicle's "sealed beam" headlamps (SB) emitting a European asymmetrical passing beam or a driving beam or both
6	Uniform provisions concerning the approval of direction indicators for power-driven vehicles and their trailers
7	Uniform provisions concerning the approval of front and rear position (side) lamps, stop-lamps and end-outline marker lamps for power-driven vehicles and their trailers
8	Uniform provisions concerning the approval of motor vehicle headlamps emitting an asymmetrical passing beam or a driving beam or both and equipped with halogen filament lamps (H1, H2, H3, HB3, HB4, H7, H8, H9, HIR1, HIR2 and/or H11)
9	Uniform provisions concerning the approval of category L2, L4 and L5 vehicles with regard to noise
10	Uniform provisions concerning the approval of vehicles with regard to electromagnetic compatibility
11	Uniform provisions concerning the approval of vehicles with regard to door latches and door retention components
12	Uniform provisions concerning the approval of vehicles with regard to the protection of the driver against the steering mechanism in the event of impact
13	Uniform provisions concerning the approval of vehicles of categories M, N and O with regard to braking
13-H	5.6.1.1 Uniform provisions concerning the approval of passenger cars with regard to braking

Regulation No.	Title
14	Uniform provisions concerning the approval of vehicles with regard to safety-belt anchorages, ISOFIX anchorages systems and ISOFIX top tether anchorages
15	Uniform provisions concerning the approval of vehicles equipped with a positive-ignition engine or with a compression-ignition engine with regard to the emission of gaseous pollutants by the engine - method of measuring the power of positive-ignition engines - method of measuring the fuel consumption of vehicles
16	Uniform provisions concerning the approval of : I. Safety-belts, restraint systems, child restraint systems and ISOFIX child restraint systems for occupants of power-driven vehicles II. Vehicles equipped with safety-belts, safety-belt reminders, restraint systems, child restraint systems and ISOFIX child restraint systems
17	Uniform provisions concerning the approval of vehicles with regard to the seats, their anchorages and any head restraints
18	Uniform provisions concerning the approval of motor vehicles with regard to their protection against unauthorized use
19	Uniform provisions concerning the approval of power-driven vehicle front fog lamps
20	Uniform provisions concerning the approval of motor vehicle headlamps emitting an asymmetrical passing beam or a driving beam or both and equipped with halogen filament lamps (H4 lamps)
21	Uniform provisions concerning the approval of vehicles with regard to their interior fittings
22	Uniform provisions concerning the approval of protective helmets and their visors for drivers and passengers of motor cycles and mopeds
23	Uniform provisions concerning the approval of reversing lights for power-driven vehicles and their trailers
24	Uniform provisions concerning: I. The approval of compression ignition (C.I.) engines with regard to the emission of visible pollutants II. The approval of motor vehicles with regard to the installation of C.I. engines of an approved type III. The approval of motor vehicles equipped with C.I. engines with regard to the emission of visible pollutants by the engine IV. The measurement of power of C.I. engine
25	Uniform provisions concerning the approval of head restraints (headrests), whether or not incorporated in vehicle seats

Regulation No.	Title
26	Uniform provisions concerning the approval of vehicles with regard to their external projections
27	Uniform provisions concerning the approval of advance-warning triangles
28	Uniform provisions concerning the approval of audible warning devices and of motor vehicles with regard to their audible signals
29	Uniform provisions concerning the approval of vehicles with regard to the protection of the occupants of the cab of a commercial vehicle
30	Uniform provisions concerning the approval of pneumatic tyres for motor vehicles and their trailers
31	Uniform provisions concerning the approval of power-driven vehicle's sealed-beam headlamps (SB) emitting an European asymmetrical passing beam or a driving beam or both
32	Uniform provisions concerning the approval of vehicles with regard to the behaviour of the structure of the impacted vehicle in a rear-end collision
33	Uniform provisions concerning the approval of vehicles with regard to the behaviour of the structure of the impacted vehicle in a head-on collision
34	Uniform provisions concerning the approval of vehicles with regard to the prevention of fire risks
35	Uniform provisions concerning the approval of vehicles with regard to the arrangement of foot controls
36	Uniform provisions concerning the approval of large passenger vehicles with regard to their general construction
37	Uniform provisions concerning the approval of filament lamps for use in approved lamp units of power-driven vehicles and of their trailers
38	Uniform provisions concerning the approval of rear fog lamps for power-driven vehicles and their trailers
39	Uniform provisions concerning the approval of vehicles with regard to the speedometer equipment including its installation
40	Uniform provisions concerning the approval of motor cycles equipped with a positive-ignition engine with regard to the emission of gaseous pollutants by the engine
41	Uniform provisions concerning the approval of motor cycles with regard to noise
42	Uniform provisions concerning the approval of vehicles with regard to their front and rear protective devices (bumpers, etc.)

Regulation No.	Title
43	Uniform provisions concerning the approval of safety glazing materials and their installation on vehicles
44	Uniform provisions concerning the approval of restraining devices for child occupants of power-driven vehicles ("child restraint system")
45	Uniform provisions concerning the approval of headlamp cleaners, and of power-driven vehicles with regard to headlamp cleaners
46	Uniform provisions concerning the approval of devices for indirect vision and of motor vehicles with regard to the installation of these devices
47	Uniform provisions concerning the approval of mopeds equipped with a positive-ignition engine with regard to the emission of gaseous pollutants by the engine
48	Uniform provisions concerning the approval of vehicles with regard to the installation of lighting and light-signaling devices
49	Uniform provisions concerning the measures to be taken against the emission of gaseous and particulate pollutants from compression-ignition engines for use in vehicles, and the emission of gaseous pollutants from positive-ignition engines fuelled with natural gas or liquefied petroleum gas for use in vehicles
50	Uniform provisions concerning the approval of front position lamps, rear position lamps, stop lamps, direction indicators and rear-registration-plate illuminating devices for vehicles of category L
51	Uniform provisions concerning the approval of motor vehicles having at least four wheels with regard to their noise emissions
52	Uniform provisions concerning the approval of M2 and M3 small capacity vehicles with regard to their general construction
53	Uniform provisions concerning the approval of category L3 vehicles with regard to the installation of lighting and light-signaling devices
54	Uniform provisions concerning the approval of pneumatic tires for commercial vehicles and their trailers
55	Uniform provisions concerning the approval of mechanical coupling components of combinations of vehicles
56	Uniform provisions concerning the approval of headlamps for mopeds and vehicles treated as such

Regulation No.	Title
57	Uniform provisions concerning the approval of headlamps for motor cycles and vehicles treated as such
58	Uniform provisions concerning the approval of: I. Rear underrun protective devices (RUPDs) II. Vehicles with regard to the installation of an RUPD of an approved type III. Vehicles with regard to their rear underrun protection (RUP)
59	Uniform provisions concerning the approval of replacement silencing systems
60	Uniform provisions concerning the approval of two-wheeled motor cycles and mopeds with regard to driver-operated controls including the identification of controls, tell-tales and indicators
61	Uniform provisions concerning the approval of commercial vehicles with regard to their external projections forward of the cab's rear panel
62	Uniform provisions concerning the approval of power-driven vehicles with handlebars with regard to their protection against unauthorized use
63	Uniform provisions concerning the approval of two-wheeled mopeds with regard to noise
64	Uniform provisions concerning the approval of vehicles with regard to their equipment which may include a temporary-use spare wheel and tyre unit, run-flat tyres and/or a run-flat system
65	Uniform provisions concerning the approval of special warning lamps for power-driven vehicles and their trailers
66	Uniform provisions concerning the approval of large passenger vehicles with regard to the strength of their superstructure
67	Uniform provisions concerning the approval of: I. Specific equipment of motor vehicles using liquefied petroleum gases in their propulsion system II. A vehicle fitted with specific equipment for the use of liquefied petroleum gases in its propulsion system with regard to the installation of such equipment
68	Uniform provisions concerning the approval of power-driven vehicles including pure electric vehicles with regard to the measurement of the maximum speed
69	Uniform provisions concerning the approval of rear marking plates for slow-moving vehicles (by construction) and their trailers
70	Uniform provisions concerning the approval of rear marking plates for heavy and long vehicles

Regulation No.	Title
71	Uniform provisions concerning the approval of agricultural tractors with regard to the driver's field of vision
72	Uniform provisions concerning the approval of motor cycle headlamps emitting an asymmetrical passing beam and a driving beam and equipped with halogen lamps (HS1 lamps)
73	Uniform provisions concerning the approval of goods vehicles, trailers and semi-trailers with regard to their lateral protection
74	Uniform provisions concerning the approval of category L1 vehicles with regard to the installation of lighting and light-signaling devices
75	Uniform provisions concerning the approval of pneumatic tires for motor cycles and mopeds
76	Uniform provisions concerning the approval of headlamps for mopeds emitting a driving beam and a passing beam
77	Uniform provisions concerning the approval of parking lamps for power-driven vehicles
78	Uniform provisions concerning the approval of vehicles of categories L_1, L_2, L_3, L_4 and L_5 with regard to braking
79	Uniform provisions concerning the approval of vehicles with regard to steering equipment
80	Uniform provisions concerning the approval of seats of large passenger vehicles and of these vehicles with regard to the strength of the seats and their anchorages
81	Uniform provisions concerning the approval of rear-view mirrors of two-wheeled power-driven vehicles with or without side car, with regard to the mounting of rear-view mirrors on handlebars
82	Uniform provisions concerning the approval of moped headlamps equipped with filament halogen lamps (HS2)
83	Uniform provisions concerning the approval of vehicles with regard to the emission of pollutants according to engine fuel requirements
84	Uniform provisions concerning the approval of power-driven vehicles equipped with internal combustion engines with regard to the measurement of fuel consumption
85	Uniform provisions concerning the approval of internal combustion engines or electric drive trains intended for the propulsion of motor vehicles of categories M and N with regard to the measurement of the net power and the maximum 30 minutes power of electric drive trains
86	Uniform provisions concerning the approval of agricultural or forestry tractors with regard to the installation of lighting and light-signalling devices

Regulation No.	Title
87	Uniform provisions concerning the approval of daytime running lamps for power-driven vehicles
88	Uniform provisions concerning the approval of retroreflective tyres for two-wheeled vehicles
89	Uniform provisions concerning the approval of: I. Vehicles with regard to limitation of their maximum speed or their adjustable speed limitation function II. Vehicles with regard to the installation of a speed limiting device (SLD) or adjustable speed limitation device (ASLD) of an approved type III. Speed limitation devices (SLD)) and adjustable speed limitation device (ASLD)
90	Uniform provisions concerning the approval of replacement brake lining assemblies and drum-brake linings for power-driven vehicles and their trailers
91	Uniform provisions concerning the approval of side-marker lamps for motor vehicles and their trailers
92	Uniform provisions concerning the approval of non-original replacement exhaust silencing systems (RESS) for motorcycles, mopeds and three-wheeled vehicles
93	Uniform provisions concerning the approval of: I. Front underrun protective devices (FUPDs) II. Vehicles with regard to the installation of an FUPD of an approved type III. Vehicles with regard to their front underrun protection (FUP)
94	Uniform provisions concerning the approval of vehicles with regard to the protection of the occupants in the event of a frontal collision
95	Uniform provisions concerning the approval of vehicles with regard to the protection of the occupants in the event of a lateral collision
96	Uniform provisions concerning the approval of compression ignition (C.I.) engines to be installed in agricultural and forestry tractors and in non-road mobile machinery with regard to the emissions of pollutants by the engine
97	Uniform provisions concerning the approval of vehicle alarm systems (VAS) and of motor vehicles with regard to their alarm systems (AS)
98	Uniform provisions concerning the approval of motor vehicle headlamps equipped with gas-discharge light sources
99	Uniform provisions concerning the approval of gas-discharge light sources for use in approved gas-discharge lamp units of power-driven vehicles

Regulation No.	Title
100	Uniform provisions concerning the approval of battery electric vehicles with regard to specific requirements for the construction, functional safety and hydrogen emission
101	Uniform provisions concerning the approval of passenger cars powered by an internal combustion engine only, or powered by a hybrid electric power train with regard to the measurement of the emission of carbon dioxide and fuel consumption and/or the measurement of electric energy consumption and electric range, and of categories M_1 and N_1 vehicles powered by an electric power train only with regard to the measurement of electric energy consumption and electric range
102	Uniform provisions concerning the approval of: I. A close-coupling device (CCD) II. Vehicles with regard to the fitting of an approved type of CCD
103	Uniform provisions concerning the approval of replacement catalytic converters for power-driven vehicles
104	Uniform provisions concerning the approval of retro-reflective markings for vehicles of category M, N and O
105	Uniform provisions concerning the approval of vehicles intended for the carriage of dangerous goods with regard to their specific construction features
106	Uniform provisions concerning the approval of pneumatic tyres for agricultural vehicles and their trailers
107	Uniform provisions concerning the approval of category M_2 or M_3 vehicles with regard to their general construction
108	Uniform provisions concerning the approval for the production of retreaded pneumatic tyres for motor vehicles and their trailers
109	Uniform provisions concerning the approval for the production of retreaded pneumatic tyres for commercial vehicles and their trailers
110	Uniform provisions concerning the approval of: I. Specific components of motor vehicles using compressed natural gas (CNG) in their propulsion system; II. Vehicles with regard to the installation of specific components of an approved type for the use of compressed natural gas (CNG) in their propulsion system
111	Uniform provisions concerning the approval of tank vehicles of categories N and O with regard to rollover stability
112	Uniform provisions concerning the approval of motor vehicle headlamps emitting an asymmetrical passing beam or a driving beam or both and equipped with filament lamps and/or LED modules

Regulation No.	Title
113	Uniform provisions concerning the approval of motor vehicle headlamps emitting a symmetrical passing beam or a driving beam or both and equipped with filament lamps
114	Uniform provisions concerning the approval of: I. An airbag module for a replacement airbag system; II. A replacement steering wheel equipped with an airbag module of an approved type; III. A replacement airbag system other than that installed in a steering wheel
115	Uniform provisions concerning the approval of: I. Specific LPG (liquefied petroleum gases) retrofit systems to be installed in motor vehicles for the use of LPG in their propulsion system II. Specific CNG (compressed natural gas) retrofit systems to be installed in motor vehicles for the use of CNG in their propulsion system
116	Uniform provisions concerning the protection of motor vehicles against unauthorized use
117	Uniform provisions concerning the approval of tyres with regard to rolling sound emissions and to adhesion on wet surfaces
118	Uniform provisions concerning the burning behaviour of materials used in the interior construction of certain categories of motor vehicles
119	Uniform provisions concerning the approval of cornering lamps for power-driven vehicles
120	Uniform provisions concerning the approval of internal combustion engines to be installed in agricultural and forestry tractors and in non-road mobile machinery, with regard to the measurement of the net power
121	Uniform provisions concerning the approval of vehicles with regard to the location and identification of hand controls, tell-tales and indicators
122	Uniform provisions concerning the approval of vehicles of categories M, N and O with regard to their heating systems
123	Uniform provisions concerning the approval of adaptive front-lighting systems (AFS) for motor vehicles
124	Uniform provisions concerning the approval of wheels for passenger cars and their trailers
125	Uniform provisions concerning the approval of motor vehicles with regard to the forward field of vision of the motor vehicle driver

Regulation No.	Title
126	Uniform provisions concerning the approval of partitioning systems to protect passengers against displaced luggage, supplied as non original vehicle equipment