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Addressed to Professional Bodies of the Automotive Sector’

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Revision [4]
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1 Introduction

Safety systems have continuously been developed since the introduction of airbags in passenger cars. Up to a few years ago, engineers focused on the secondary safety field, but it has become apparent that major new breakthroughs seem unlikely for the near future.

On the contrary, it is the experts’ opinion that significant breakthroughs will take place in the primary safety field. This is due to the increasing feasibility of including electronic components and informatics in the development of primary safety systems. Some systems, such as the ESP, are becoming standard features in vehicles today and new technologies, such as collision avoidance systems are being introduced into the market. These advancements are providing increased safety for vehicle occupants, resulting in reduced road related injuries and fatalities.

The main objective of Work Package 1 is to intrigue the interest of the end users about various safety systems included in vehicles, as a large number of individuals are not aware of all systems available. This project primarily targets passenger car users but also motorcyclists and heavy vehicle drivers/companies.

In this project almost all existing and near-future safety systems were collected and categorised according to some parameters, such as their safety function and road user. This summary of safety technologies is included in the document accompanied with a brief description for each system.

Finally the most noteworthy systems were selected as it was concluded that the end users should be aware and informed about them. It is considered that the vehicle dealers should act as the mediators between the manufacturer and the client. This report except a technical document should also be a guide for the end users.
2 Definitions

As the main objective is to classify and analyse the Advanced Driver Assistance Systems (ADAS), as well as the Intelligent Vehicle Safety Systems (IVSS), a general description is given as follows:

2.1 ADAS

Advanced Driver Assistance Systems (ADAS) are those that help the driver to maintain safe and comfortable control and steering of their vehicle, improving vehicle and road users' safety through the use of the latest technologies. The purpose of these technologies is to make decisions on the current safety level of the vehicle through data acquisition from both the vehicle’s environment and also on the state of the driver. The system then takes actions in order to avoid conflictive situations or possible accidents. This is achieved by either taking control of the vehicle itself or by alerting the driver.

A common characteristic of most ADA systems, whether they automate (part of) the driver's tasks or 'just' give an instructive message, is the inclusion of on-board sensors such as radar to scan the direct vicinity of the vehicle, determining for instance the progress of the vehicle and the road ahead.

2.2 IVSS

Intelligent Vehicle Safety Systems use Information and Communication Technologies for providing solutions for improving road safety in particular in the pre-crash phase when the accident can still be avoided or at least where its severity can be significantly reduced. With these systems, which can operate either autonomously on-board the vehicle, or be based on vehicle-to-vehicle or vehicle-to-infrastructure communication (co-operative systems), the number of accidents and their severity can be reduced, leading equally to a reduction of the number of fatalities and injuries.

The IVSS programme aims to stimulate R&D to produce the traffic safety solutions of the future, activities that may result in smart technology and IT solutions that prevent fatalities and serious injuries as the result of crashes. Key areas include:
- Driver support & human-machine interface systems
- Communication platforms, both internal and external
- Sensor-rich embedded systems
- Intelligent roads and informatics
- Dependable systems
- Vehicle dynamic safety systems
- Crashworthiness, bio-mechanics and injury prevention
3 Description of the systems

3.1 Categories and their Definitions

Every system will be classified under three basic criteria, according to “when” it has to act, “who” is it made for (the user) and “which” its main function is.

3.1.1 Classifications according to their action

Primary Safety Systems → these systems act as first line of defence against the prevention of accidents. Main objective is to improve the vehicle safety through development of new technology with aim of preventing or avoiding vehicle crashes. Examples include ABS, Traction Control System (TCS) and Electronic Stability Control (ESC).

Secondary Safety Systems → these systems have been designed in order to protect and reduce the risk of injury to the vehicle occupants’ in the case of a crash occurring. The most common examples include the use of airbags or seatbelts.

Tertiary Safety Systems → relatively new concept, concerned with the alerting of rescue services after an accident has happened. The advancements in the field of electronics have helped develop new methods of alerting rescue services, one such system is Emergency Calling, with more common systems such as roadside call-boxes and mobile telephones also proving to be particularly useful.

3.1.2 Classification according to the road user:

As it is known, safety systems are not only conceived for passenger cars; they are also useful for any kind of vehicle, such as the heavy ones, motorcycles and pedestrians, which are often involved in traffic accidents. As a consequence, the following classification has been made, according to the “user” of the safety system.

- Passenger Cars
- Motorcycles
- Pedestrians
- Heavy Vehicles
- Roads (Road Infrastructure)
3.1.3 Classification according to the safety function of the systems

Safety systems are becoming more and more numerous year after year; as most of them do a similar function, they can be classified under the same field. So, they can be categorized in five main functions:

- Drive Safe
- Braking Systems
- Handling/Kinematics
- Visibility
- Restraints

3.2 Definition of systems

3.2.1 Passenger Cars

Primary safety

- Braking Systems

### ANTILOCK BRAKING SYSTEM

*Classification:* Primary Safety / Passenger Cars / Braking System

*Description:* System that avoids locking the wheels when braking. Particularly on slippery roads, even the lightest application of the brakes can lead to wheel lock-up. The vehicle does not react to the driver’s steering movements.

With ABS the vehicle remains under control so that it can be steered around an unexpected obstruction even when the driver has slammed the brakes in panic. Rotational-speed sensors continuously monitor each wheel. As soon as incipient lock-up is detected at a wheel, ABS temporarily reduces the braking pressure at the wheel in question to such a degree that lock-up is prevented. ABS repeats this monitoring and control cycle in rapid succession for each wheel. This form of electronic wheel-slip control ensures optimum braking distances while at the same time maintaining full steerability and stability.

### CORNERING BRAKE CONTROL

*Classification:* Primary Safety / Passenger Cars / Braking System
Description: The cornering brake control system works together with traditional anti-lock braking systems to overcome any over-steer which results from attempting a corner too quickly. The braking for each wheel also work independently such as in the Sensotronic Brake Control system.

### ELECTRO MECHANICAL BRAKE

**Classification:** Primary Safety / Passenger Cars / Braking System

**Description:** With the EMB gets involved in pure brake-by-wire technology, which dispenses with brake fluids and hydraulic lines entirely. The braking force is generated directly at each wheel by high performance electric motors, controlled by an ECU, and actuated by signals from an electronic pedal module. The EMB includes all brake and stability functions such as ABS, EBD, TCS, ESC*, BA and ACC. It is virtually noiseless, even in ABS mode. This is an x-by wire technology that allows no physical contact between braking pedal and the braking system and no hydraulic system in the car. It allows a more compact system and disassembling the brake pedal structure and the hydraulic system, very useful to increase the lower leg survival space during front crashes.

### ELECTRO HYDRAULIC BRAKE

**Classification:** Primary Safety / Passenger Cars / Braking System

**Description:** Compared to the operation of conventional braking systems, by depressing the brake pedal with the Electro Hydraulic Brake System (EHB) the appropriate command is transmitted electronically to the electronic controller of the hydraulic unit. This determines the optimum braking pressure and actuates the brake callipers hydraulically. This is an x-by wire technology that allows no physical contact between braking pedal and the braking system. It allows a more compact system and disassembling the brake pedal structure, very useful to increase the lower leg survival space during front crashes.

### DYNAMIC BRAKE CONTROL

**Classification:** Primary Safety / Passenger Cars / Braking System

**Description:** This system is a hydraulic brake pressure reinforcement safety system used in order to provide the maximum braking pressure specifically in emergency stopping situations where the shortest possible braking distance is necessary. The system only works when the brake pedal is depressed very firmly and quickly, i.e. specifically just in emergency situations.
## ELECTRO HYDRAULIC PARKING BRAKE

**Classification:** Primary Safety / Passenger Cars / Braking System  

**Description:** Compared to the operation of conventional braking systems, by depressing the brake pedal with the Electro Hydraulic Brake System EHB the appropriate command is transmitted electronically to the electronic controller of the hydraulic unit. This determines the optimum braking pressure and actuates the brake callipers hydraulically. This is an x-by wire technology that allows no physical contact between braking pedal and the braking system. It allows a more compact system and disassembling the brake pedal structure, very useful for the survival space during front crashes.

## ELECTRONIC PARKING BRAKE

**Classification:** Primary Safety / Passenger Cars / Braking System  

**Description:** The EPB consists of an electronic controller and an electro-mechanical central actuator, which actuates duo-servo brakes or a combined calliper via Bowden cables. The advantages demonstrated by the EPB compared to conventional parking brakes are: improved safety, simple operation, diagnostic system, and emergency service brake system, automatic tightening and loosening, hill start assist, vehicle immobiliser...

## BRAKE ASSIST SYSTEM

**Classification:** Primary Safety / Passenger Cars / Braking System  

**Description:** Brake assist systems are an important aid in emergency braking situations - such as when the driver applies the brake fast, but not with sufficient pressure, which leads to dangerously long braking distances. The brake assist recognizes the brake application speed to detect this type of panic situation and activates the brake booster or the EBS hydraulic unit, so that even with moderate pedal forces maximum deceleration is achieved. There are several methods to implement these features. The Electronic BAS interacts with the vacuum brake booster, the ABS, the ESP and the ACC. The Mechanical BAS replaces the electronic system that detects pedal velocity by an inertial mechanism. The Hydraulic BAS bases directly in ESP components. The assist function is triggered through extension of the software routines.

## HYDRAULIC BRAKE BOOST

**Classification:** Primary Safety / Passenger Cars / Braking System
### Description:
This system is designed for use in both passenger cars and heavy vehicles; however the main focus is on the installation onto heavy vehicles. This is a hydraulically powered unit, providing a means of power assist when applying hydraulic brakes. It consists of a booster unit, which is combined with a master cylinder that then forms a brake actuation unit. The advantage of this system is the great reduction in the amount of pedal effort required in order to provide the desired amount of brake force.

### SENSOTRONIC BRAKE CONTROL

**Classification:** Primary Safety / Passenger Cars / Braking System

**Description:** A newly developed electronic brake control system. When the driver applies brake pressure on the pedal, the connected piston activates a brake booster. As a result when more pressure is put on the pedal, more brake pressure is released. The advantage of this system is that it is independent for each wheel, therefore keeping better control in poor weather or on corners.

### ELECTRONIC BRAKE DISTRIBUTION

**Classification:** Primary Safety / Passenger Cars / Braking System

**Description:** When braking, the weight distribution of the car changes. Front wheels support more weight than rear wheels. So, rear wheels are more likely to lock and slide, which means losing the control of the vehicle. This is the reason why braking force has to be distributed between front and rear wheels. Old vehicles had limitation valve that did not allow braking pressure rise upon a certain value. With the introduction of ABS, the function of the pressure limitation valve is implemented directly by a software routine in the ABS ECU.

- Drive Safe

### ADVANCED ADAPTIVE CRUISE CONTROL

**Classification:** Primary Safety / Passenger Cars / Drive Safe

**Description:**
1. Information and Warning system
   A Vehicle will transmit a warning message when it detects a vehicle breakdown, high traffic density and congestion or dangerous road surface conditions.
2. Communication-based Longitudinal Control System
   Existing ACC only react to vehicles in front of them. By integrating communication, these systems may adapt longitudinal control to the traffic in front and can allow anticipating to an early braking manoeuvre when an invisible vehicle beyond the direct predecessor in front is braking. This leads to more natural following behaviour.

3. Co-operative Assistance system
   A Typical scenario for co-operation is the highway entry and margining scenario. By exchanging information up to simple trajectory plans, critical situations can be foreseen and solved by the vehicles.

### COLLISION WARNING SYSTEM

**Classification:** Primary Safety / Passenger Cars / Drive Safe

**Description:** The crash warning system works in a similar way to the crash avoidance systems. A radar system is used in order to detect any particular hazards that may present themselves in the course of driving, such as another vehicle intercepting the path of this. The system is particularly useful in bad driving conditions, such as heavy rain or snow as well as at night when visibility is limited. An alarm will sound to warn the driver with progressively louder signals as the vehicle closes in on the hazard.

### LANE KEEPING ASSISTANCE

**Description:** Lane Departure Warning System (LDW) will warn the driver if he or she is on the verge of inadvertently drifting out of the lane. Using a CMOS Camera and an image-processing algorithm, this driver assistance system registers the course of the lane in relation to the vehicle. The system "sees", as it were, the course of the road and where the car is going. If the warning algorithm detects an imminent leaving of the current driving lane, the system warns the driver with haptic, kine-static, or acoustical feedback. Possible warning alerts can be a trembling in the steering wheel, a vibrating seat or a virtual washboard sound (a noise people recognize as generated by driving over a lane marker at highway construction sites).

Lane Keeping System (LKS), as a next step, becomes an active lane keeping assistant, through an intervention in the steering. Just like LDW, the LKS measures the vehicle position relative to the lane, but offers active support in keeping the vehicle to the lane. However, the driver always retains the driving initiative, meaning that although he can feel the recommended steering reaction as a gentle movement of the steering wheel, his own decision takes priority at all times.

### BLIND SPOT DETECTION
<table>
<thead>
<tr>
<th>Classification: Primary Safety / Passenger Cars / Drive Safe</th>
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<tr>
<td><strong>Description:</strong> The camera-based monitoring system keeps watch for other vehicles travelling in the blind spot. When another vehicle enters the monitored zone, a warning light is illuminated near the exterior side mirror. Both sides of the vehicle are monitored in the same way. This visual warning gives the driver a clear indication that another vehicle is alongside. The system also alerts the driver both to vehicles approaching from behind and vehicles in front being overtaken.</td>
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<th>HILL DESCENT CONTROL</th>
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<td><strong>Classification:</strong> Primary Safety / Passenger Cars / Drive Safe</td>
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<td><strong>Description:</strong> HDC enables the vehicle to take even the steepest downhill gradients safely and reliably, automatically reducing the velocity of the car to walking speed without the driver having to brake. As an option HDC can be controlled via buttons in the multifunction steering wheel.</td>
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<th>SAFE SPEED AND SAFE FOLLOWING (SASPENCE)</th>
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<td><strong>Classification:</strong> Primary Safety / Passenger Cars / Drive Safe</td>
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<td><strong>Description:</strong> The SASPENCE system is conceived to support the driver, suggesting the proper velocity and distance, given the road conditions, traffic density, road geometry, frontal obstacles, potentially dangerous road locations, and weather conditions. The system will suggest and help the driver to keep the proper speed and headway, according to the reconstructed driving context, preventing risky and dangerous situations, and thus avoiding collision.</td>
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<th>OVERSPEED WARNING SYSTEM</th>
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<td><strong>Classification:</strong> Primary Safety / Passenger Cars / Drive Safe</td>
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<td><strong>Description:</strong> The over-speed warning system is generally an audio signal to advise the vehicle driver of an over-speed. The system is not mandatory and is set by the driver. It is just an audio signal and by no means overrides the vehicle to decrease speed.</td>
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<th>SPEED LIMITER SYSTEM</th>
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### Description
The speed limiter can be an internal system integrated by the vehicle manufacturer or an option, which the vehicle driver can set them. If the system is determined by the manufacturer then it is normally much higher than most allowable maximum speeds on European roads, however if set by the driver, it can be adjusted depending on the maximum speed of the particular road. This system is purely voluntary. Once the set speed is reached, the vehicle will stop accelerating; however this can be over-ridden by the driver if necessary by pressing the accelerator.

### INTERSECTION CONTROL (INTERSAFE)
**Classification:** Primary Safety / Passenger Cars / Drive Safe

**Description:** A driver warning function based on communication with traffic lights and path prediction of all objects using the intersection.

### REAR DISTANCE PARKING AID
**Classification:** Primary Safety / Passenger Cars / Drive Safe

**Description:** The back up sensing system prevents the car from hitting another car, hitting the wall, etc. This device is equipped with a proximity sensor located in the rear portion of the vehicle that is why during backing it gives off a warning that the rear end of your car is going to hit an object.

### SELF PARKING SYSTEM
**Classification:** Primary Safety / Passenger Cars / Drive Safe

**Description:** To set up the system, you'll install a reflective lens against the wall at the head of the parking space. A cam mounted on your BMW's front windshield will measure the distance and angle of the car relative to the lens. The car uses information from the sensors to calculate an entry trajectory, and then navigates the vehicle into its parking spot. This advanced parking assistance system builds on ultrasonic sensors to help you judge the distance from your car to other cars and to unseen objects when you're parking. Parking assistance will use the same sensors to brake and steer around objects in the car's trajectory.

### DEFLATION DETECTION SYSTEM
**Classification:** Primary Safety / Passenger Cars / Drive Safe
**Description:** DDS, an indirect measuring low-cost system, gives a warning signal when there is a decrease in tire pressure. DDS requires no sensors of its own but evaluates the data gathered via the EBS wheel speed sensors. Any loss of pressure changes the radius of the tires, and results in a specific alteration of the speed signal. Integrating the system into EBS software in this manner makes DDS an interesting solution that is very economical.

**RUN-FLAT TYRE**

**Classification:** Primary Safety / Passenger Cars / Drive Safe

**Description:** Combines an innovative tyre with an innovative rim. The rim has a tyre-supporting ring integrated into it that springs into action immediately after a major loss of inflation pressure. The tyre itself has a shorter sidewall than today's standard tyres of comparable circumference and a flexible bead. With this bead, it is inserted into a newly developed bead chamber. It is then fixed permanently into place during mounting by means of a filler ring. CWS enables the vehicle to continue on its way in the event of a puncture, at least as far as the next repair-shop. The nominal run-flat distance is rated at 200 km at a maximum speed of 80 km/h.

- Handling/Kinematics

**TRACTION CONTROL SYSTEM**

**Classification:** Primary Safety / Passenger Cars / Handling/Kinematics

**Description:** In order to maintain directional stability and prevent the vehicle breaking away, the wheels should neither lock up during braking, nor should they spin when driving off. TCS prevents the wheels from spinning. It ensures good traction, stability and steer-ability when driving off or accelerating. Wheel-speed sensors continuously monitor each wheel. TCS evaluates the wheel-speed sensor signals and immediately recognises when a wheel is about to start slipping. In this case TCS is activated and regulates the drive torques of the driven wheels. This electronic wheel-slip control selectively brakes individual wheels and intervenes in the engine management. Alongside an improvement in driving stability and safe acceleration, the Traction Control System also reduces tire abrasion.

**AUTOMATIC STABILITY CONTROL + TRACTION**

**Classification:** Primary Safety / Passenger Cars / Handling/Kinematics
**Description:** This is a suspension control system where the engine can reduce the overall output to prevent wheel-spin when accelerating on loose surfaces, ice or in extremely wet conditions. If black ice or similar surface is met, this is instantly recognised by the system and the wheels are prevented from locking.

**ANTI SLIP REGULATION**

**Classification:** Primary Safety / Passenger Cars / Handling/Kinematics

**Description:** A method for providing traction to wheels in order to prevent the slipping or loss of traction of the wheel(s). In the case of one wheel slipping (for 2-wheel drive vehicle), the system will apply a brake to this wheel and transfer more torque to the other, higher gripping wheel. In the case of 2 wheels spinning, a reduction in the total engine torque provided will be completed by the system.

**ACCELERATION SKID CONTROL**

**Classification:** Primary Safety / Passenger Cars / Handling/Kinematics

**Description:** The ASC was developed to control the interplay of the longitudinal forces between tires and road surface not only under braking but, for the first time, also under acceleration by acting upon both the brakes and the engine torque. It detects drive-wheel slip and prevents loss of traction by braking the slipping wheel. Power can then be re-directed to another wheel with more traction.

**DYNAMIC SUSPENSION SYSTEM**

**Classification:** Primary Safety / Passenger Cars / Handling/Kinematics

**Description:** This system enhances on- and off-road handling, by varying the amount of torsional stiffness in the front and rear stabilizer bars. When the driver is travelling at high speeds on paved roads, the stabilizer bars have maximum stiffness, to keep the vehicle flat during cornering. However, if the driver goes off-road, the bars disengage. This allows the wheels to articulate according to need. The result is better traction on uneven trails, and a more comfortable ride.

**TORSEN DIFFERENTIAL**

**Classification:** Primary Safety / Passenger Cars / Handling/Kinematics
**DESCRIPTION:** On the permanent all-wheel drive (torsen differential), power is distributed as needed to all four wheels. This system provides high levels of active safety, and dependable traction on virtually all surfaces as well as excellent road holding, even in cross-winds. It is superior to manual all-wheel-drive systems because of this permanent safety advantage. Depending on the driving situation and road surface, torsen differential technology distributes drive power continuously between the front and rear axles.

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**VISCOSOUS COUPLING DIFFERENTIAL LOCK**

**CLASSIFICATION:** Primary Safety / Passenger Cars / Handling/Kinematics

**DESCRIPTION:** Viscous Coupling Differential Lock, allows infinitely variable distribution of drive forces between the front and rear wheels, modifying the flow of power at a speed never seen before. The system immediately recognises the need to change engine power, where appropriate, and respond within fractions of a second. Viscous Coupling Differential Lock acts faster than other systems, because it is able to think ahead and anticipate upcoming situations on the road. To offer this unique benefit, Viscous Coupling Differential Lock uses information from the wheel sensors showing the system whether a wheel is about to spin and providing data gathered by DSC stability control.

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**ACTIVE DIFFERENTIAL**

**CLASSIFICATION:** Primary Safety / Passenger Cars / Handling/Kinematics

**DESCRIPTION:** The unit can be viewed as a hydraulic pump, where the housing and the annular piston are connected to one shaft and a piston actuator is connected to the other. When both shafts are rotating at the same speed, there is no pumping action. As soon as a speed difference occurs, the pumping and oil flow start. As a piston pump, there is virtually instant reaction with no low-speed pumping loss. The oil flows to a clutch piston, compressing the clutch pack, braking the speed difference. The oil returns to the reservoir via an adjustable throttle valve, which controls the oil pressure and thereby the force on the clutch pack.

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- Visibility

**ADAPTIVE LIGHT**

**CLASSIFICATION:** Primary Safety / Passenger Cars / Visibility
**Description:** The adaptive light system has an additional light unit located between the low-beam and main-beam bulbs of the xenon plus headlights. With the low-beam lights switched on and up to a speed of 70 km/h, this light unit is activated if the turn indicator is operated for some time or if the driver steers sharply. If the driver engages reverse gear, the additional headlights are automatically activated on both sides of the vehicle. This considerably improves visibility and orientation when reversing.

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<th><strong>HEADLAMP ASSIST</strong></th>
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<td><strong>Classification:</strong> Primary Safety / Passenger Cars / Visibility</td>
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<td><strong>Description:</strong> Headlamp Assist uses a light sensor on the windscreen to detect light levels. Meaning that when it is dark, or if you drive into a car park or tunnel, the lights automatically turn on for you (and off when you come out) although foggy conditions require manual operation.</td>
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<th><strong>HEADLIGHT WASHING SYSTEM</strong></th>
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<td><strong>Classification:</strong> Primary Safety / Passenger Cars / Visibility</td>
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<td><strong>Description:</strong> A headlight washing system is a washing device that cleans the headlamps an as such ensures better visibility. The system could consist of a high pressure-spraying device. In addition to the regular cold wash systems also system exists spraying a heated cleaning fluid. This is especially relevant with fibre optic headlight systems that stay cool, so snow, ice, and salt simply stays put.</td>
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<th><strong>HEAD-UP DISPLAY</strong></th>
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<td><strong>Classification:</strong> Primary Safety / Passenger Cars / Visibility</td>
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<td><strong>Description:</strong> This critical information is projected onto the windscreen in clear view of the driver, but does not distract his or her view of the road ahead. A heads-up display presents virtual colour-coded tach (redline for which varies according to engine temperature) and information on speed and current gear.</td>
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<th><strong>REAR LIGHT BRAKE FORCE DISPLAY</strong></th>
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**Description:** Rear Light Brake Force Display works by increasing the intensity of the brake lights in the rear lamp clusters by expanding the number of illuminated LEDs when heavy braking is detected. The extra lighting is triggered after the brake sensors detect a certain rate of deceleration, e.g. in excess of 5 m/s². The Rear Light Brake Force Display is not triggered by pedal pressure in order to avoid unnecessary illumination. The system reacts within a few tenths of a second to increase the intensity of the stoplight illumination, projecting a highly visible warning beacon to following traffic.

**MIRRORS WITH AUTOMATIC DIP FUNCTION**

**Classification:** Primary Safety / Passenger Cars / Visibility

**Description:** The automatic-dip inside and outside mirrors identify excessively bright headlight beams behind the car and darken the mirror glass automatically. An electronic control unit varies the darkening effect quickly and continuously according to actual ambient light conditions.

**AUTOMATIC WINDSHIELD WIPERS**

**Classification:** Primary Safety / Passenger Cars / Visibility

**Description:** System that turns on the windshield wipers of the car when it is needed. The system is very simple. The driver does not have to care about the wipers. When some water or dust is detected in the windscreen, wipers are turned on automatically. The speed of the wipers is also adapted. It is very useful in bad weather conditions.

**MOISTURE SENSING**

**Classification:** Primary Safety / Passenger Cars / Visibility

**Description:** Special sensors reduce window fogging and increase climatic comfort by means of interior moisture management. Based on the data provided by the moisture and temperature sensor, the dew point temperature of the air is calculated in the climate control unit. The temperature at the windscreen is measured without contact via the infrared radiation sensor. To prevent the windscreen from fogging over, the electronic climate control regulates the temperature of the windscreen so that it is higher than the dew point temperature of the air.

**Secondary Safety**

- **Structural**
### INTERIOR LAYOUT

**Classification:** Secondary Safety / Passenger Cars / Structural  
**Description:** Poorly laid-out controls could require a driver to spend too much time looking for functions and not focusing on the road ahead, which potentially affects safety. Impact absorbing interior materials, provide padding and cushioning on dashboards and armrests to cut down on the bumps and bruises caused by crashes.

### DEFORMABLE STRUCTURE

**Classification:** Secondary Safety / Passenger Cars / Structural  
**Description:** The structure of a vehicle is a compromise between stiffness and controlled deformation. The aim of the structure when an impact occurred is to preserve the occupant’s space integrity. This is possible if there are some parts of the car that are able to preserve the survival space after the crash, and some others that absorb a great quantity of energy during the accident by collapsing. The rest of passive safety devices are based on a good structural performance of the vehicle body.

### SAFETY CELL

**Classification:** Secondary Safety / Passenger Cars / Structural  
**Description:** A "safety cell" construction surrounds the entire vehicle interior with a structural cage. In the event of a crash, the safety cell resists the force of the collision on the passenger compartment, helping to reduce the intrusion in and deformation of the passenger compartment to ensure sufficient survival space for the car occupants. In addition, crumple zones are used to absorb some of the energy of a crash, dissipating it to protect the passenger compartment safety cell.

### SIDE-IMPACT PROTECTION

**Classification:** Secondary Safety / Passenger Cars / Structural  
**Description:** Side Impact Protection is a general term related to all primary and secondary safety systems that aim to prevent side impact crashes or reduce the injury risk of the occupants during a side impact. Commonly used side impact protection systems are side impact bars to reduce the amount of structural deformation in the passenger and driver area and side airbags to minimize head injuries.
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<th><strong>LAMINATED WINDSCREEN</strong></th>
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<tr>
<td><strong>Description:</strong></td>
<td>The objectives are a) to avoid large sharp pieces of glass, b) to maintain the integrity of the windscreen even in case of damage and c) to reduce the amount of flying glass. Both occupants and external road are less likely exposed to sharp edges of the remainders of the windscreen. It is however harder to smash which may cause delay to rescue operation.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>ENHANCED PROTECTIVE GLASS</strong></th>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>Classification:</strong></td>
<td>Secondary Safety / Passenger Cars / Structural</td>
</tr>
<tr>
<td><strong>Description:</strong></td>
<td>Is the laminated glass placed on the rear and side windows of some cars. It consists in a glass made by a layer of special plastic called butyric polyvinyl assembled between two layers of glass. The principal aim of the EPG is to prevent the occupant total or partial ejection in case of accident, as well as laceration reduction. EPG also provides significant increases to intrusion resistance enough to deter most would-be thieves, as well as helps provides protection from outside wind and road noise, harmful ultraviolet rays, and reduces interior heat build up by reflecting up to 60 percent of heat creating IR rays.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>WELL SUPPORTED SEATS</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Classification:</strong></td>
<td>Secondary Safety / Passenger Cars / Structural</td>
</tr>
<tr>
<td><strong>Description:</strong></td>
<td>Except for the seats to be manufactured including the latest passive safety technology such as sliding and anti-whiplash seats, they need to be well-supported to provide the driver and passengers with comfort and for safety issues.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>ENERGY ABSORBING STEERING COLUMN</strong></th>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>Classification:</strong></td>
<td>Secondary Safety / Passenger Cars / Structural</td>
</tr>
<tr>
<td><strong>Description:</strong></td>
<td>The active energy absorbing steering columns have the ability to automatically adjust within milliseconds of a crash to the driver weight and size, seat belt usage, vehicle speed and crash severity.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>SAFETY PEDAL SYSTEM</strong></th>
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</thead>
<tbody>
<tr>
<td><strong>Classification:</strong></td>
<td>Secondary Safety / Passenger Cars / Structural</td>
</tr>
</tbody>
</table>
**Description:** The system is intended to prevent driver's feet from being trapped underneath the pedals in case of a frontal crash, especially when footwall intrusion occurs. Different solutions exist, most work either by releasing the pedal mount or by a linkage that directs pedals in an inward/upward direction on impact.

- **Restraints**

<table>
<thead>
<tr>
<th><strong>RE-ACTIVE HEAD RESTRAINT</strong></th>
<th>Classification: Secondary Safety / Passenger Cars / Restraints</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>In case of a rear impact re-active head restraint systems use the force that the body applied to the back rest of the seat to move the headrest closer to the head.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>PRO-ACTIVE HEAD RESTRAINT</strong></th>
<th>Classification: Secondary Safety / Passenger Cars / Restraints</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>The sensors of a pro-active head restraint system detect the car acceleration, in case of a rear impact, send a signal to the control unit, and it deploys the head rest, that moves forward and upward, getting closer to the occupant’s head. These systems do not use the force of the occupants body applied to the back rest of the seat to move the headrest closer to the head.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>SELF INFLATING HEAD RESTRAINT</strong></th>
<th>Classification: Secondary Safety / Passenger Cars / Restraints</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>The system consists of an air-filled bag in the backrest. In a rear-end collision, the air is pressed to a second, smaller bag in the headrest to reduce the gap between the headrest and the head. The system works with no sensor or firing unit and is reversible.</td>
</tr>
</tbody>
</table>

| **SLIDING SEATS** | Classification: Secondary Safety / Passenger Cars / Restraints |
Description: A unique solution with a seat system that moves forward, a bit like a sled, at the same time as the front is deformed. This movement is slowed with the help of adaptive shock absorbers that tailor the damping effect to suit the collision force and the occupants' number and weight. The moving part of the interior encompasses the front seats, rear seat - and the floor panel between the two areas. What is more, the steering wheel and a movable dash panel move forward as well, to create space for the driver's movement. The sliding components are unlocked and the dampers activated in the event of a crash severe enough to deploy the airbags. The seats slide forward/rearward on guide-tracks. The system is also extended for rear impact by allowing the seats to translate rearward by 3 inches, which reduces the forces on the occupants. The moving interior is also utilised to aid entry to the rear seat. All it takes is to press a button on the door pillar and all seats slide forward.

ANTI-WHIPLASH SEATS

Classification: Secondary Safety / Passenger Cars / Restraints

Description: Anti-Whiplash Seat (AWS) is based on a yieldable backrest that tilts in a controlled way in a rear-end collision to absorb energy and reduce the forward rebound of the occupant. For front-seat occupants, the anti-whiplash system AWS has proven to be very effective in rear-end impact test. In a study by the U.S. Insurance Institute for Highway Safety, for instance, the Neck-Injury-Criterion (NIC) levels were reduced by approximately 50%, to levels that are deemed to be safe. These rear-end crash tests were performed at 15 mph or 24 km/h.

SEAT BELT REMINDER

Classification: Secondary Safety / Passenger Cars / Restraints

Description: Visual and audible warning that encourages the occupants of the vehicle to use the seat-belt. It can be available in different places of the vehicle and so, apart from the driver it needs to determine whether the occupant is present or not. Its use is been generalized after being considered as a positive modifier on the EURO NCAP assessment.

SEAT BELTS

Classification: Secondary Safety / Passenger Cars / Restraints
**Description:** Seat belts are estimated to reduce the overall risk for serious injuries in crashes by 60-70% and the risk for fatalities by about 45 percent. In non-collisions, mainly rollovers, the reduction in fatalities is about 75%. In high-speed collisions, however, rib and abdominal injuries may be suffered, especially if the seat belt is not correctly positioned. These risks are minimized with seat belts pre-tensioners, load limiters. Height adjusters improve the seat belts' protective effect by achieving correct belt geometry. They also increase the ease and the comfort of use for car occupants of above or below average height. Retractors have two sensors that work independently on the locking mechanism. The vehicle sensor detects sudden deceleration of the vehicle, while the webbing sensor detects violent pull-outs of webbing from the retractor.

### BELT-IN SEATS

**Classification:** Secondary Safety / Passenger Cars / Restraints

**Description:** These types of seats have the seat belt incorporated and fixed directly the seat itself as appose to the more traditional means of fixing it to the B-pillar. The advantage of this is the better position for the shoulder belt to wrap around the occupants body, and thereby increasing the overall efficiency of the system. This system is particularly useful in the case of a rollover accident, where the superior restraint helps prevent collision between the occupants’ head and the roof of the vehicle.

### 4 POINT SAFETY BELT

**Classification:** Secondary Safety / Passenger Cars / Restraints

**Description:** This is also a belt-in seat with four attachment points (two shoulder, two hips, with an “X” or “V” shape), that improves the efficiency spreading out the energy of the moving body in a collision over the chest, pelvis, and shoulders, and lowering the risk of body rotation, compared to the three-point belts, in case of an offset collision. As most of the frontal collisions are not full frontal, it is widely observed that even when using a 3-point safety belt there is still a high risk of impact of the occupant’s outboard head, chest and abdomen, with the side interior structure of the car.

### SEAT BELT PRE-TENSIONERS & LOAD LIMITERS

**Classification:** Secondary Safety / Passenger Cars / Restraints
**Description:** Pretensioners react in the first milliseconds of an impact to automatically tighten the belts and help hold the individual in position against the seatback. To help prevent the pretensioner from causing undue pressure on the chest, load limiters slightly relieve belt tension, as needed, to soften their force.

**CONSTANT FORCE RETRACTORS**

**Classification:** Secondary Safety / Passenger Cars / Restraints

**Description:** Developed by DaimlerChrysler, constant force retractors are “a mechanical device in the front seat belts designed to mitigate the force of a seat belt according to the load or force exerted on it. CFR’s are engineered to force-limit the belt system and gradually release seat belt webbing in a controlled manner during a severe crash.

**CHILD RESTRAINT SYSTEMS**

**Classification:** Secondary Safety / Passenger Cars / Restraints

**Description:** These seats are separate and can be moved from one vehicle to another and positioned at best suitable place in the vehicle. Please note that no rearward facing child seat should be placed in a seat with a passenger airbag, frontal or side. In general, rearward facing seats for 0-4 years children and forward facing booster cushions for older children. In order to place the seat in the vehicle it is important to know if that sitting position is a Universal Position (one can fit all CRS types) and if it has a frontal airbag. In case it has, it has to be disabled.

**CHILD RESTRAINT SEAT FIXING**

**Classification:** Secondary Safety / Passenger Cars / Restraints

**Description:** The “lower universal anchorage system” for child restraints is a new standardized method of installing a child seat without using a seatbelt. This system is based on the ISOFIX, an international standard developed by ISO (International Standards Organization). The vehicle anchor system has small bars built into the crease of the vehicle seat back. The upper anchor is the tether anchorage slot. The corresponding child seat will have two attachments (either straps or solid connectors) that work with these bars, as well as the usual tether strap.
# LOWER ANCHORS AND TEATHERS FOR CHILDREN

**Classification:** Secondary Safety / Passenger Cars / Restraints

**Description:** The Lower Anchors and Teathers for Children is a system for providing a standard mean of installing a child seat in a vehicle. It is designed for easy installation, without the need for the vehicles’ seatbelt system. It is standard to have this system (US) or the similar ISOFIX system integrated into new vehicle design.

# FRONTAL AIRBAGS

**Classification:** Secondary Safety / Passenger Cars / Restraints

**Description:** The ECU is usually installed in the middle of the car, between the passenger and engine compartment. The sensor (an micro-machined accelerometer) continuously monitors the acceleration and deceleration of the vehicle and sends this information to a micro processor where the crash algorithm - or the "crash pulse" - of a vehicle is stored. The algorithm's parameters are adjusted and optimized per car model.

When the micro processor "recognizes" the crash pulse from the sensor, an electrical current is sent to the initiator (or squib) in the micro gas generators of the seat belt pre-tensioners and/or in the inflator of the airbag(-s) that should be deployed. Capacitors in the ECU are used as back-up energy, in case the main battery of the vehicle is disconnected during the crash. A redundant safing function prevents cellular telephones and other electro magnetic interference from setting off the airbags inadvertently.

The size of the cushion varies from 35 to 70 litres for the driver side airbag and from 60 to as much as 160 litres for the passenger side airbag. The bag is fully inflated within 50 thousands of a second - half the time of the blink of the eye - and deflated within two tenth of a second.

# SIDE AIRBAGS

**Classification:** Secondary Safety / Passenger Cars / Restraints

**Description:** Side-impact collisions account for a quarter of all injuries to car occupants, but they account for more than one third of the serious and fatal injuries. One major reason is that the side of the vehicle is a thin crumple zone and the space between the occupant and the side of the vehicle is small.

Inflatable curtains cover the entire upper part of a vehicle's side, cushioning the heads of the driver and all passengers (both front and rear seat occupants) seated next to the side. Stored in the head liner above the doors, the cells of the IC are inflated in less than 25 thousands of a second (four times faster than the blink of an eye). To avoid stitches from sewing the bag, its cells are woven on the loom directly from the yarn. Therefore the bag can remain inflated for several seconds, which is imperative in roll-over accidents.
Thorax airbags are estimated to reduce the serious chest injuries in side-impact collisions by approximately 25%. Side airbags that include head protection are reducing deaths by about 45% among drivers of passenger cars struck on the near (driver) side. Mortality reductions also were substantial when the striking vehicles were pickups or SUVs, suggesting that head-protecting side airbags are addressing some of the problems of incompatibility when passengers’ cars are struck in the side by vehicles with higher ride heights. The protective effect is obtained by keeping the occupant away from the impact zone, and dampening the blow from the intruding side of the vehicle. Since the occupant is kept away from the intruding vehicle side, protection of the head is also improved. For adequate head protection special airbags are required, however. The thorax bag is inflated within 12 thousands of a second; four times as fast as a frontal airbag. The bag is inflated at a certain crash threshold, usually corresponding to a speed of the impacting vehicle of more than 15-20 km/h.

### KNEE/LEG AIRBAG

**Classification:** Secondary Safety / Passenger Cars / Restraints

**Description:** Knee Airbag not only protects the knees (and the hips), but also reduces the risk for “submarining” (gliding under the belt). It also provides benefits for the head and the chest by keeping the occupant in the proper position to receive maximum protection afforded by the regular frontal airbag. In addition, Autoliv's knee airbag allows for more functional, roomy styling in the vehicle interior and a more lightweight solution than metal bars and other traditional knee protection alternatives.

### ANTI SLIDING AIRBAG

**Classification:** Secondary Safety / Passenger Cars / Restraints

**Description:** The Anti-Sliding Bag is installed in the front edge of the seat cushion to reduce the risk of the occupant sliding under the seatbelt in a crash. The system keeps the occupant’s knees and legs at a safe distance from the instrument panel and improves the protection of the seatbelts by reducing the risk for injuries to the abdomen. It also improves the protection provided by the frontal airbags by keeping the occupant in a more upright position so the occupant’s impact is against the entire bag instead of just the lower part of the bag.

### INFLATABLE CURTAIN

**Classification:** Secondary Safety / Passenger Cars / Restraints
### INFLATABLE CURTAIN

**Description:** The inflatable Curtain (IC) covers the entire upper part of a vehicle's side, cushioning the heads of the driver and all passengers seated next to that side. It can be designed to protect one row (A to B pillar), 2 rows (A to C pillar) or 3 rows (A to D pillar) of occupants.

### INFLATABLE CARPET

**Classification:** Secondary Safety / Passenger Cars / Restraints

**Description:** This system is designed to protect the car occupant's feet and lower legs in frontal crashes. It consists of an inflatable mat in the front footwell.

### ADVANCED HEAD PROTECTION SYSTEM

**Classification:** Secondary Safety / Passenger Cars / Restraints

**Description:** The system is intended to protect the occupant's head from impacts to the side part of the passenger cabin or to intruding external objects. Available systems are either dedicated curtain- or tube-shaped head airbags or chest airbags that extend upward to cover the head.

- Drive Safe

### OCCUPANT POSITION DETECTION SYSTEM

**Classification:** Secondary Safety / Passenger Cars / Drive Safe

**Description:** This system is intended to detect occupant position in case of an upcoming crash. This information can be used to de-power or de-activate airbags if they can not be safely fired due to an out-of-position occupant. Various sensor technologies have been suggested ranging from seat frame strain gauges and pressure sensitive mats to cameras and image recognition. The system may be combined with a seat occupation detection system that prevents the deployment of airbags if the respective seat is not occupied.

### INTELLIGENT PROTECTION SYSTEM

**Classification:** Secondary Safety / Passenger Cars / Drive Safe
### Description
The IPS is a fully integrated, computer-driven system that 'thinks' about, and responds to, different accident conditions. IPS features integrated seat belt buckle pre-tensioners, energy management retractors, seat belt usage sensors, a driver's seat position sensor, dual stage inflating airbags and a special crash severity sensor.

### PRE-SAFE

**Classification:** Secondary Safety / Passenger Cars / Drive Safe

**Description:** PRE-SAFE® advance protection measures use some information from the sensors of established and familiar systems like Brake Assist or ESP, which detect critical situations such as skidding or emergency braking at an early stage. In case of such a critical situation, PRE-SAFE® triggers the reversible belt tensioners on the front seats, while the front passenger seat and the individual seats in the rear are adjusted to a more favourable position in case a crash occurs. And if the sensors detect severe over-steer or under-steer which could potentially be followed by a roll-over, the sunroof is automatically closed too. In case no crash occurs, the measures are reversed.

### ROLLOVER SYSTEM

**Classification:** Secondary Safety / Passenger Cars / Drive Safe

**Description:** Rollover System is related to all primary and secondary safety systems that aim to prevent a rollover or reduce the injury risk of the occupants during a rollover. Examples of a secondary rollover protection system are roll bars that minimize roof deformation during a rollover and curtain airbags that are fired to minimize head injuries in case a rollover is detected.

### ROLLOVER PROTECTION

**Classification:** Secondary Safety / Passenger Cars / Drive Safe

**Description:** An active roll-over protection system behind the rear head restraints. This provides additional protection for the occupants if the vehicle rolls over. A highly sensitive system of sensors detects the vehicle movements and triggers two protective bars which extend within milliseconds. Together with the extremely rigid windscreen frame, these help to maintain survival space for the occupants and ensure open-top driving pleasure – the safe way.

### SAFETY BATTERY TERMINAL

**Classification:** Secondary Safety / Passenger Cars / Drive Safe
**Description:** This system disconnects the battery from the unfused starter / generator cable in case of a severe crash. Other electrical systems such as lights or communication equipment are not affected. The objective is to prevent fire hazard resulting from short circuits. The system works on a pyrotechnical basis and is usually fired by the same control unit as the airbags.

**Tertiary Safety**

- Rescue

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**EMERGENCY CALL**

*Classification:* Tertiary Safety / Passenger Cars / Rescue

*Description:* eCall is a high priority area within the European Commission. In order to help stakeholders better understand all of the aspects and issues surrounding the Emergency Call (eCall) chain, eScope has created the dedicated eCall Toolbox.

The use of in-vehicle emergency call (eCall) to deploy emergency assistance will save lives and reduce the social burden of road accidents by improving the notification of such accidents, speeding up the emergency service response and lowering the subsequent effects on fatalities, severity of injuries and traffic flows.

eCall is an emergency call either generated manually by vehicle occupants or automatically via activation of in-vehicle sensors when an accident occurs. When activated, the in-vehicle eCall system establishes a 112-voice connection directly with the relevant PSAP (Public Service Answering Point), which is a public authority or a private eCall centre that operates under the regulation and/or authorisation of a public body. At the same time, a minimum set of data (MSD) – including key information about the accident such as time, location and vehicle description – is sent to the PSAP operator receiving the voice call. The minimum set of data may also contain the link to a potential Service Provider by including its IP address and phone number.

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**AUTOMATIC CRASH NOTIFICATION**

*Classification:* Tertiary Safety / Passenger Cars / Rescue

*Description:* This is a system of automatic notification to emergency services of the occurrence of an accident and the accident severity.

It works through a series of sensors which measure the severity of the accident through deformation pulses and the activation of safety systems such as airbags. Once the severity has been defined, a message is sent to a call centre where the accident is logged. Included is the accident severity and if any dangerous good are carried in the vehicle.
The result is the rescue services will be able to respond according to the specific accident characteristic.

### EMERGENCY RESPONSE SYSTEM

**Classification:** Tertiary Safety / Passenger Cars / Rescue

**Description:** The emergency response system is currently under development and integration by a number of manufacturers. For example, the system currently being implemented into a select few of Daimler Chryslers' vehicles prepares the vehicle after an accident by turning on interior lights, unlocking doors and shutting off fuel switches. These actions are all activated as soon as an airbag is deployed. Some of the systems available from other manufacturers switch on hazard lights, disconnect the battery from the alternator and inform emergency services of the crash.

#### 3.2.2 Motorcycles

**Primary Safety**

- Braking Systems

### ANTILOCK BRAKING SYSTEM

**Classification:** Primary Safety / Motorcycles / Braking Systems

**Description:** See Passenger cars for description

**Secondary Safety**

- Rider Protection

### MOTORCYCLE HELMET

**Classification:** Secondary Safety / Motorcycles / Rider Protection

**Description:** The motorcycle helmet was the original safety feature for motorcycle riders. They provide protection to the riders' head in the case of an accident. The clear shield also allows for optimum vision and prevents injury to the riders' face from example loose rocks of a proceeding vehicle. The wearing of motorcycle helmets is mandatory in most countries.
PROTECTIVE CLOTHING

*Classification:* Secondary Safety / Motorcycles / Rider Protection

*Description:* Constructed of durable materials, protective clothing including a riders' suit, gloves and boots should be worn in order to protect the rider from injury if involved in an accident.

BACK PROTECTOR

*Classification:* Secondary Safety / Motorcycles / Rider Protection

*Description:* The back protector offers support and protection to a rider’s back in the case of an accident or falling off the motorcycle. Back injuries are one of the most common, proving the potential of this simple, but effective system.

RIDER AIRBAG

*Classification:* Secondary Safety / Motorcycles / Rider Protection

*Description:* Working in the same way, however in the more difficult circumstances of a motorcycle, the rider airbag in one of the few passive safety systems a motorcycle rider can make use of. The difficulties of the system arise because the rider is not restrained in the same way as a car occupant and are therefore free to move in any direction. The system is effective through in a frontal crash.

3.2.3 Pedestrians

Primary Safety

- Drive Safe

PEDESTRIAN DETECTION & WARNING SYSTEM

*Classification:* Primary Safety / Pedestrians / Drive Safe

*Description:* A system that combines pedestrian detection, trajectory estimation, risk assessment and driver warning. The detection component consists of a cascade of module, each utilizing different visual criteria to successively focus on relevant image regions, carefully balancing robustness and efficiency considerations.
The tracking component aggregates per-frame detections to trajectories by a tracking module. Finally, the risk assessment and warning/control component evaluates the probability of collision; if the latter exceeds a threshold an acoustic driver warning is given or automatic vehicle braking is applied.

**VULNERABLE ROAD USERS PROTECTION (SAVE-U)**

*Classification:* Primary Safety / Pedestrians / Drive Safe

*Description:* The system calculates in a matter of seconds the movement of pedestrians within the `capture zone` which can be up to 30 meters away from the vehicle. The camera tracks the pedestrian movement and the information is correlated with the data received from the radar network (speed of and distance to object). SAVE-U can consequently identify any pedestrian or cyclist coming within the trajectory of the vehicle and after analysing the situation, warn the driver or apply automatic braking if there is a risk of collision.

**Secondary Safety**

- Drive Safe

**ACTIVE HOOD**

*Classification:* Secondary Safety / Pedestrians / Drive Safe

*Description:* Head-contact with rigid engine surfaces causes severe injuries and fatalities in pedestrian impacts. Active Hood systems serve to prevent this. Sensors in the vehicle bumper can differentiate between a human leg and a lamppost; send a signal which raises the rear half of the hood through 2 steel bellows. This allows the pedestrians’ head to impact this raised and therefore more energy absorbent surface, reducing the chances of fatality and injury.

3.2.4 Heavy vehicles

**Primary Safety**

- Braking Systems

**ANTILOCK BRAKING SYSTEM**

*Classification:* Primary Safety / Heavy Vehicles / Braking Systems
<table>
<thead>
<tr>
<th><strong>TELLIGENT BRAKE SYSTEM</strong></th>
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<tbody>
<tr>
<td><strong>Classification:</strong> Primary Safety / Heavy Vehicles / Braking Systems</td>
</tr>
<tr>
<td><strong>Description:</strong> A modern electro-pneumatic braking system developed by Mercedes Benz to improve the effectiveness of vehicle braking and improve stopping distances. The system is based upon an electronically controlled 10-bar dual-circuit brake system which incorporates ABS, ASR and other auxiliary braking systems. This system is also useful in improving the equalisation of brake lining wear on different axles and prolonging the life of other braking processes.</td>
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<thead>
<tr>
<th><strong>ELECTRONIC BRAKE DISTRIBUTION</strong></th>
</tr>
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<tbody>
<tr>
<td><strong>Classification:</strong> Primary Safety / Heavy Vehicles / Braking Systems</td>
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<tr>
<td><strong>Description:</strong> See Passenger Cars for Description</td>
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<thead>
<tr>
<th><strong>BRAKE ASSIST</strong></th>
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<tr>
<td><strong>Classification:</strong> Primary Safety / Heavy Vehicles / Braking Systems</td>
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<tr>
<td><strong>Description:</strong> See Passenger Cars for Description</td>
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<tr>
<th><strong>RETARDERS</strong></th>
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<tbody>
<tr>
<td><strong>Classification:</strong> Primary Safety / Heavy Vehicles / Braking Systems</td>
</tr>
<tr>
<td><strong>Description:</strong> Currently hydraulic, electronic, exhaust and compression retarders exist. They work as an auxiliary braking aid for trucks in order to ensure the effectiveness of the normal wheel disc brakes. They offer light braking on gradients, for example, where excess use of the trucks' brakes would cause them to overheat and limit their efficiency. They work by bypassing the relevant energy type (through hydraulics or exhaust, etc) and creating braking power.</td>
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<thead>
<tr>
<th><strong>BRAKE BLENDING</strong></th>
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<tbody>
<tr>
<td><strong>Classification:</strong> Primary Safety / Heavy Vehicles / Braking Systems</td>
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</tbody>
</table>
**Drive Safe**

**ADAPTIVE CRUISE CONTROL**

*Classification:* Primary Safety / Heavy Vehicles / Drive Safe  
*Description:* See Passenger Cars for Description

**LANE DEPARTURE WARNING SYSTEM**

*Classification:* Primary Safety / Heavy Vehicles / Drive Safe  
*Description:* See Passenger Cars for Description

**OBJECT DETECTION**

*Classification:* Primary Safety / Heavy Vehicles / Drive Safe  
*Description:* There are several systems working together to detect objects in front of the vehicle/sides and rear to help warn of and prevent accidents, and to help minimize the impact of a collision once an accident becomes unavoidable. A short-range radar sensor paired with a monocular camera is used to assist the driver in detecting vehicles or object. If an object is detected, a visual or audible warning is activated.

**SPEED LIMITER**

*Classification:* Primary Safety / Heavy Vehicles / Drive Safe  
*Description:* See Passenger Cars for Description

**PARKTRONIC**

*Classification:* Primary Safety / Heavy Vehicles / Drive Safe

*Description:* A combination of systems which optimise the braking effort of a truck through increased interaction of disc brakes, engine brake and retarders.
**Description:** When reversing with little room to spare, systems like Parktronic can make the driver’s life a lot easier. Parktronic is an electronic aid that provides visual and audible signals to warn of a risk of collision when maneuvering in confined spaces at speeds up to 16 km/h. The system operates on the echo sounder principle. Sensors on the rear bumpers emit ultrasonic signals, which are reflected back by other vehicles or obstacles in the driver’s path.

### DRIVER INFORMATION SYSTEM

**Classification:** Primary Safety / Heavy Vehicles / Drive Safe

**Description:** The driver information system in the instrument cluster is the car's display and information centre. It provides information on the current operating status, including for example auto check control messages and - depending on the car's equipment - radio, telephone and navigation data.

- Handling/Kinematics

### ESP

**Classification:** Primary Safety / Heavy Vehicles / Handling/Kinematics

**Description:** See Passenger Cars for Description

### TRACTION CONTROL SYSTEM

**Classification:** Primary Safety / Heavy Vehicles / Handling/Kinematics

**Description:** See Passenger Cars for Description

### ROLL STABILITY CONTROL

**Classification:** Primary Safety / Heavy Vehicles / Handling/Kinematics

**Description:** Rollover crash avoidance system is designed to help stabilize a vehicle in order to help reduce the risk of a rollover. This system focuses on the vehicle’s center of gravity and the lateral acceleration limit or rollover threshold. The system constantly monitors driving conditions and intervenes if critical lateral acceleration is detected.
The system provides control of engine and retarded torque as well as automatically activates the drive axle and trailer brakes. Roll stability control systems take corrective action, such as throttle control or braking, when sensors detect that a vehicle is in a potential rollover situation.

**DYNAMIC STEERING RESPONSE**

*Classification:* Primary Safety / Heavy Vehicles / Handling/Kinematics

*Description:* Dynamic steering response (DSR) is a safety technique that corrects the rate of hydraulic or electric power steering system to adapt it to vehicle's speed and road conditions. It turns the steering, brakes, transmission and chassis into a single, responsive unit that transforms every intention into instant, precise control.

- Visibility

**TWIN LENSE HEADLAMP**

*Classification:* Primary Safety / Heavy Vehicles / Visibility

*Description:* Twin Lense Headlamp provides intense light beam concentration and improves driver's night vision by generating a greater on-road presence.

**ADAPTIVE FRONT LIGHTING**

*Classification:* Primary Safety / Heavy Vehicles / Visibility

*Description:* See Passenger Cars for Description

**NIGHT VISION ASSIST**

*Classification:* Primary Safety / Heavy Vehicles / Visibility

*Description:* See Passenger Cars for Description

**HIGH INTENSITY DISCHARGE BULBS**

*Classification:* Primary Safety / Heavy Vehicles / Visibility

*Description:* See Passenger Cars for Description
<table>
<thead>
<tr>
<th><strong>Secondary Safety</strong></th>
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<tr>
<td><strong>Structural</strong></td>
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</tbody>
</table>

**COLLAPSIBLE STEERING COLUMN**

*Classification*: Secondary Safety / Heavy Vehicles / Structural

*Description*: A collapsible steering column will collapse in the event of a heavy frontal impact to avoid excessive injuries to the driver.

**UNDERRUN PROTECTION SYSTEM**

*Classification*: Secondary Safety / Heavy Vehicles / Structural

*Description*: Due to differences in size it is important to offer protection to opposing vehicle in an accident involving a Heavy Vehicle. The front underrun protection system, which is now standard on many newly built truck is a system which prevents an oncoming car from being ‘wedged’ under the front of the truck, therefore reducing the possibility of serious injury or fatality for the occupants of the car. Underrun guards are the name given to the guards placed around all sides of a heavy vehicle trailers. Similar to the front underrun protection system, these prevent any vehicle from entering or being trapped under a trailer.

**DUAL CRASH RESISTANT**

*Classification*: Secondary Safety / Heavy Vehicles / Structural

*Description*: Dual crash resistant system is a structural modification to the design of a coach or bus. The system uses a more durable triangular tubular construction which is more effective for preventing intrusion in to the vehicle survival space as compared to the more traditional square tubular construction.

**EMERGENCY LIGHTING**

*Classification*: Secondary Safety / Heavy Vehicles / Structural

*Description*: Emergency Lights are external devices of the vehicle that keep the driver, the passengers and the vehicle visible during roadside distress situations such as flat tires, engine trouble, empty gas tanks, etc. When drivers are stranded on the roadside, emergency safety lighting ensure them stay visible. Such devises can be either a simple flash light or newer products like light sticks, led flashers or spotlights.
### EMERGENCY WINDOWS

**Classification:** Secondary Safety / Heavy Vehicles / Structural

**Description:** Emergency windows are designed such that the entire window unit, including both glass panes and the window frame, are removed, providing a realistic evacuation exit. The efficacy of emergency windows is not in the least dependent on how far the individual upper glass pane can be opened. Emergency exit windows are easily recognizable by the instruction sticker and the bright red handle at the top.

- Restraints

### HEAD RESTRAINT SYSTEM

**Classification:** Secondary Safety / Heavy Vehicles / Restraints

**Description:** The system is entirely mechanical and is based on the lever principle. An upper padded support is connected to a pressure plate in the backrest of the seat. In some rear collisions, the occupant’s body will be forced by the crash pulse into the backrest, which moves the pressure plate towards the rear. Subsequently, the head restraint is moved up and forward to “catch” the occupant’s head before the whiplash movement can start. The precise activation of the system is determined by the force with which the occupant’s back is forced against the backrest, the magnitude of the collision forces and by the occupant’s weight.

### 3 POINT SAFETY BELT

**Classification:** Secondary Safety / Heavy Vehicles / Restraints

**Description:** The three-point seatbelt has a single continuous length of webbing having three attachment points (one shoulder, two hips). The three-point seat belt helps spread out the energy of the moving body in a collision over the chest, pelvis, and shoulders.

### 2 POINT SAFETY BELT

**Classification:** Secondary Safety / Heavy Vehicles / Restraints

**Description:** A restraint system with two attachment points. A lap belt (rarely can be diagonal with 2 attachment points).

### SEAT BELT TENSIONERS
### CHILD BOOSTER CUSHION

**Classification:** Secondary Safety / Heavy Vehicles / Restraints  
**Description:** A current problem is the correct restraint of children on buses or coaches. This is because modern coach/bus restraint systems are mainly intended for adult use and therefore a child is not as accurately restrained due mainly to their smaller size. The addition of a booster cushion raises the child towards the restraint to a level closer to that of an adult, therefore increasing the usability of the restraint system.

### FRONTAL AIRBAGS

**Classification:** Secondary Safety / Heavy Vehicles / Restraints  
**Description:** See Passenger Cars for Description

### ACTIVE KNEE PROTECTION

**Classification:** Secondary Safety / Heavy Vehicles / Restraints  
**Description:** See Passenger Cars for Description

- Drive Safe

### ROLLOVER PROTECTION SYSTEM

**Classification:** Secondary Safety / Heavy Vehicles / Drive Safe  
**Description:** 60% of truck occupant fatalities involve a rollover. RollTek is a system that provides rollover protection for HGV.  
SENSING: The roll sensor senses an imminent rollover  
PRETENSIONING: The belt pretensioner tightens the seat belt securely around the belted occupant  
POSITIONING: The S4 lowers the suspension seat to its lowest position  
DEPLOYMENT: The side airbag deploys
FIRE SUPPRESSION SYSTEM

*Classification:* Secondary / Heavy Vehicles / Drive Safe

*Description:* When a vehicle gets into an accident, a sensor is used to set off a fire suppression system that could be put in the engine compartment and/or the fuel tank. The system is designed specifically for use in closed cockpit vehicles. It gives an even two-litre split between engine and cockpit compartments to put the fire off.

AUTOMATIC FUELPUMP SHUT-OFF

*Classification:* Secondary Safety / Heavy Vehicles / Drive Safe

*Description:* See Passenger Cars for Description In most vehicles, the fuel pump delivers a constant flow of gasoline to the engine; fuel not used is returned to the tank. This further reduces the chance of the fuel boiling, since it is never kept close to the hot engine for too long. Some vehicles with an electronic control unit have safety logic that will shut the electric fuel pump off even if the ignition is "on" if there is no oil pressure, either due to engine bearing damage or a stalled engine in a car accident. In case of an accident this will also prevent fuel leaking from any ruptured fuel line. Other cars have an additional roll over valve that will shut off the fuel pump in case the car rolls over.

Tertiary Safety

- Rescue

EMERGENCY CALL

*Classification:* Tertiary Safety / Heavy Vehicles / Resue

*Description:* See Passenger Cars for Description

3.2.5 Roads

Primary Safety

- Road Layout

ANTI-SKID SURFACES
**Classification:** Primary Safety / Roads / Road Layout

**Description:** By using high friction textures the chance a car collides will go down. Braking distances will be shorter and avoidance manoeuvres will be quicker carried out. Rumble stripes give audio feedback to the driver. This extra information besides the visual feedback is good for distracted or sleepy drivers who are not seeing the road marks and crosses them. The stripes have a third dimension, when a wheel rolls over the marking it will start vibrating and gives feedback to the vehicle driver.

---

**ROAD MARKINGS**

**Classification:** Primary Safety / Roads / Road Layout

**Description:** Highly visible road markings give better feedback to the car driver. Especially during the night and under bad weather conditions such as rain and snow drivers are able to keep their lanes better.

---

**SIGNING**

**Classification:** Primary Safety / Roads / Road Layout

**Description:** Signs give drivers feedback on a coming danger or a change in the existing situation. Good visible signs are preventing for surprises to the driver. The better the driver is informed the better the driver can act in a safe way.

---

**HEATED ROAD**

**Classification:** Primary Safety / Roads / Road Layout

**Description:** The concept of a heated road. Due to sun radiation roads are heated during the day. The road surface heats up. By providing the road by an ingenious system with heat exchangers the energy can be stored under the road in the ground. In the case of an iced road, the road can be heated by the stored energy in the ground. An advantage of exchanging heat is that the road temperature at sunny days will be lower. It means that the temperature differences of the road will be smaller, which means rather less wear of the road.

The energy consumption is rather low because the sun is used as energy source. In the figure an overview of the principle of a heated road is given.
**LIGHTING**

*Classification*: Primary Safety / Roads / Road Layout

*Description*: Today, street lighting commonly uses high-intensity discharge lamps, often HPS high-pressure sodium lamps. Such lamps provide the greatest amount of Photopic illumination for the least consumption of electricity. Lighting has the potential to significantly reduce road accidents. The reduction in the number of accidents attributable to lighting appears to stand at about 33% of the total number of accidents.

---

**ROUNDBOUBLE SCHEME**

*Classification*: Primary Safety / Roads / Road Layout

*Description*: Side impact accidents are in general rather violent, and should be avoided. Often, these accidents happen on road crossings. In order to reduce direct crossing traffic, roundabouts are constructed to avoid crossing vehicles. As a result, the number of side impact accidents will decrease. Roundabouts have a second advantage, which is the speed reduction on the roads. Vehicles have to slow down in order to pass safely the roundabout. A third advantage of roundabouts is that they are safe for vulnerable road users.

---

**SHELTER TURNING LANES**

*Classification*: Primary Safety / Roads / Road Layout

*Description*: Divided lanes avoid vehicles to cross each other. When vehicles have to cross each other to go in different directions, the collision risk is high. By guiding the cars well in advance before the turning lanes and then separate the traffic lanes from each other by a physical divider, the traffic view for the driver becomes less diffuse.

---

**PEDESTRIAN CROSSINGS**

*Classification*: Primary Safety / Roads / Road Layout

*Description*: Technologies to increase the visibility of pedestrian crossings, to improve safety of pedestrians. Infrastructural changes to improve visuality by reflective paint and reflective or lighted signs, as well as physical obstacles to slow down vehicles.
### RED LIGHT CAMERAS

**Classification:** Primary Safety / Roads / Road Layout  

**Description:** Red Light Cameras force the drivers to attend the signs. Several researches show effectiveness of this equipment. Enforcement of keeping the rules increases the traffic safety.

### SPEED CAMERAS

**Classification:** Primary Safety / Roads / Road Layout  

**Description:** Designed to Avoid Driver Speeding. Speeding drivers decrease the safety on the roads. Not only the chance of an accident happening is higher; also the severity of an accident is worse.

### Secondary Safety

- Energy Absorbing Structures

### LATTIX POST

**Classification:** Secondary Safety / Roads / Energy Absorbing Structures  

**Description:** Lattix, is used as a passive safety pole, the distinctive triangular or quadrangular posts offer a stable support structure for even the largest directional and gantry signs. Its energy-absorbing qualities, which minimise injury to vehicle occupants, also contribute greatly to road safety. It does not require crash cushion protection, has no bolts or fixings, and does not corrode.

### SAFETY FENCES

**Classification:** Secondary Safety / Roads / Energy Absorbing Structures  

**Description:** Prevent Collisions with Oncoming Vehicles. Safety fences divide traffic flows with different direction. When separated collisions are rarely to happen. Fences can be made in different shapes.

### PEDESTRIAN GUARDRAIL
Classification: Secondary Safety / Roads / Energy Absorbing Structures

Description: Prevents Vehicle Collision with Pedestrian. Devices to separate vulnerable road users from fast moving traffic. The devices are mainly to avoid pedestrians from approaching the dangerous high speed lanes.

**CONCRETE MEDIAN BARRIERS**

Classification: Secondary Safety / Roads / Energy Absorbing Structures

Description: Prevent Collisions with Oncoming Vehicles. Safety fences divide traffic flows with different direction. When separated, collisions are rarely to happen. Fences can be made in different shapes.

**CRASH BARRIERS**

Classification: Secondary Safety / Roads / Energy Absorbing Structures

Description: Prevent Collisions with Oncoming Vehicles. Crash Barriers divide traffic flows with different direction. When separated collisions are rarely to happen. Crash Barriers can be made in different shapes.

**WIRE ROPE BARRIERS**

Classification: Secondary Safety / Roads / Energy Absorbing Structures

Description: Prevent Collisions with Oncoming Vehicles. Wire Rope Barriers divide traffic flows with different direction. When separated collisions are rarely to happen.

**DOUBLE ROADSIDE BARRIERS**

Classification: Secondary Safety / Roads / Energy Absorbing Structures

Description: Prevent Collisions with Oncoming Vehicles. Safety barriers divide traffic flows with different direction. When separated collisions are rarely to happen. Barriers can be made in different shapes.

Tertiary Safety

- Rescue

**EMERGENCY CALL BOXES**
**Classification:** Tertiary Safety / Roads / Rescue

**Description:** Roadside Telephone System. Emergency Call Boxes inform rescue units to attend the accident when it occurs. The box automatically contacts the rescue service. The information comes from the crashed cars which give a signal to the emergency call box.

**DYNAMIC LANES**

**Classification:** Tertiary Safety / Roads / Rescue

**Description:** In the event of an emergency or breakdown, a motorist can pull into the hard shoulder to get out of the flow of traffic and obtain an element of safety. A hard shoulder also allows some extra flexibility should a motorist need to take evasive action, as it is a buffer area between the main thoroughfare and the edge of the road. Emergency vehicles such as ambulances and police cars may also use the shoulder to bypass traffic congestion.
4 System analysis

As seen above, 156 safety systems have been found through research, some including safety systems currently on the market and some future trends for passenger cars, heavy vehicles etc. After a deep analysis, a list of 14 main systems has been selected. The selection criteria have been:

- Systems developed mainly for passenger cars.
- Present in the market in no more than five years.
- The most promising systems, in terms of efficiency in accident reduction, according to experts’ expectations.
- Trying to cover all the map of safety groups.

4.1 Listing of selected systems

4.1.1 Braking

<table>
<thead>
<tr>
<th>1.- BRAKING ASSIST SYSTEM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Classification:</strong> Primary Safety / Passenger Cars / Barking System</td>
</tr>
<tr>
<td><strong>Description:</strong> The Predictive Brake Assist is the first safety system that in advance processes the relevant information from the vehicle’s surroundings and reacts before the impending accident actually takes place.</td>
</tr>
</tbody>
</table>

Using the data from the Adaptative Cruise Control’s radar sensor, PBA detects dangerous situations and in which emergency braking will be needed. If such a dangerous situation does occur, PBA prepares the brake system in advance for panic braking. Pilot pressure is applied to the brake system so that the required brake pressure can be generated more quickly, and the brakes are applied very gently so that the driver doesn’t notice. In addition PBA lowers the triggering threshold for the hydraulic brake-assist system in three stages. It is possible to be combined with the Adaptive Brake Lights, system that triggered by the strengths of brake activation the rear brake lights are illuminated in different kinds to indicate emergency braking manoeuvres to the following vehicles.
2. - ELECTRONIC STABILITY CONTROL

**Classification:** Primary Safety / Passenger Cars / Handling Kinematics

**Description:** Safety system that recognizes unstable driving conditions at the very outset and applies automatic, corrective action. ESP helps the driver overcome critical situations and keep his vehicle safely under control.

ESC continuously evaluates the measured data from numerous sensors and compares the driver's input with the actual behaviour of the vehicle. If an unstable condition develops - such as a sudden evasive manoeuvre - within a fraction of a second, ESC intervenes via engine electronics and the brake system to help stabilize the vehicle.

3. - ACTIVE FRONT STEERING

**Classification:** Primary Safety / Passenger Cars / Handling Kinematics

**Description:** The Active front steering system, provides more direct direction to low speed, by what it can be operated in a more agile way, whereas on having increased the speed, the direction becomes more indirect, with a quieter behavior on to drive to high speeds.

1. Active front steering is a controlled system electronically that modifies the relation of the direction in normal conditions of driving to low or average speed, achieving that it is more direct, with what applying a minor draft of the steering wheel is obtained a major draft of the wheels. On the contrary, on having driven to high speed, the direction is more indirect, with what the path is more stable and the vehicle reacts with more precision.
2. This system has turned into natural something, almost invisible for the driver.
3. The Active front steering has a system of regulation of the car draft on its vertical axis, that can be interconnected with the system Dynamic Stability Control, thus when this one tries to correct a slide or skid, the active front steering can help to restore the control of the vehicle with what the system Dynamical Control of Stability has to work later.
4. Future, It has different modalities of functioning to select for the driver.
4.1.3 Visibility

4.- ADVANCED FRONT LIGHT SYSTEM

**Classification:** Primary Safety / Passenger Cars / Visibility

**Description:** The Advanced Front Light System improves night-time driving safety. The headlamps follow the direction in which the driver is steering.

Concept of intelligent lighting, according to curves, weather conditions and speed. It estimates where you will be in three seconds' time, using sensors that monitor your speed and the angle of your front wheels, and shines the car's headlights in that direction. The left and right headlamps swivel by different amounts depending on the way you are turning.

5.- VISION ENHANCEMENT / NIGHT VISION / VULNERABLE ROAD USERS' PROTECTION

**Classification:** Primary Safety / Passenger Cars / Visibility

**Description:** Assistance function that allows the driver to see at night further down the road than the headlights illuminate.

The Night Vision system is an assistance function with camera techniques like infra-red which enhances the perception of pedestrian and other relevant objects at night or in otherwise bad vision conditions.

4.1.4 Drive Safe

6.- ADVANCED ADAPTATIVE CRUISE CONTROL

**Classification:** Primary Safety / Passenger Cars / Drive Safe

**Description:** This system regulates the speed of cruise and it controls automatically the safety distance with regard to the car that is circulated ahead.

1. The system regulates the cruise speed.
2. ACC system is a relatively new technology. With the help of a system of radar it controls of automatic form the safety distance with the car that circulates ahead, stopping the vehicle if it is necessary. It uses a system of radar for this reason the weather does not affect it.
3. The system of detection of traffic signs by means of cameras is other of the functions of the advanced ACC. It warns the driver of the maximum allowed speed.
4. Through to the system of images recognition, it detects exactly form the edges that delimit the rails.
5. It has a system of control speed in curve, which if it acts together with a navigation system, adapts the speed to the tracing curve.

### 7.- LANE KEEP ASSISTANT / LANE DEPARTURE WARNING

<table>
<thead>
<tr>
<th>Classification:</th>
<th>Primary Safety / Passenger Cars / Drive Safe</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>The Lane Departure Warning System is a new driving aid that detects unintentional lane departures at speeds of 80 kph and above. Lane Keep Assistant also apply a force over the steering wheel to aid driver to keep in the lane.</td>
</tr>
</tbody>
</table>

The system is triggered automatically when the driver mistakenly allows the vehicle to stray out of lane. It works as follows: when the vehicle moves across road markings without the indicator being used, infrared sensors behind the front bumper detect the movement and trigger the ECU which warns the driver. Some systems use video image processing technology to recognize road markings.

### BLIND SPOT DETECTION/ MONITORING

<table>
<thead>
<tr>
<th>Classification:</th>
<th>Primary Safety / Passenger Cars / Drive Safe</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>The system monitors traffic approaching from behind or in the driver’s blind spot, will warn the driver if they are about to make a potentially unsafe change lanes or turn.</td>
</tr>
</tbody>
</table>

The same radar sensors also provide information for a safe door-opening function, warning the driver of any cyclists, people on roller-blades or vehicles approaching from behind before opening the door. Side sensing supports drivers in detecting vehicles within the “blind spot” to the rear of their own vehicle, to facilitate safe lane changes on motorways.

LCA incorporates basic blind spot monitoring, which is fundamentally a short-range sensing mode, with longer range sensing to detect vehicles in adjacent lanes, which may be rapidly approaching and could also pose a hazard in a lane change maneuver.

### 8.- DRIVER DROWSINESS DETECTION/DRIVER CONDITION MONITORING

<table>
<thead>
<tr>
<th>Classification:</th>
<th>Primary Safety / Passenger Cars / Drive Safe</th>
</tr>
</thead>
</table>
**Description:** By monitoring the eyes, it is believed that the symptoms of driver fatigue can be detected early enough to avoid a car accident.

There are some ways of detecting drowsiness, but they are based in eyes closure. One way is a video system that detects the eyes of the driver and measures directly the eye closure. Another way is a neural network model used to estimate the eye closure using measures associated with lane keeping, steering wheel movements and lateral acceleration of the vehicle. The warnings begin as the driver becomes fatigued and intensify as the system detects increasing drowsiness, providing the driver with the opportunity for countermeasures such as napping or getting a cup of coffee before they endanger himself and/or others.

---

**9.- ALCOHOL INTERLOCK / ALCOLOCK KEYS**

**Classification:** Primary Safety / Passenger Cars / Drive Safe

**Description:** Alcohol interlocks are devices that require the driver to take a breath test before starting the car.

1. The alcohol interlock is a breath testing device connected to the ignition system of a motor vehicle. It prevents an operator from starting the vehicle if the breath alcohol concentration (BAC) exceeds a predeterminated threshold or fail level.
2. The use of Breath Alcohol Ignition Interlock Devices is embedded in a program of monitoring and servicing, sometimes complemented with medical and/or psychological interventions.

---

**10.- INTELLIGENT SPEED ADAPTATION**

**Classification:** Primary Safety / Passenger Cars / Drive Safe

**Description:** The system alerts the driver with audio and/or visual when the speed exceeds the locally valid legal speed limits.

The speed limit information is either received from transponders in speed limit signs or from a digital road map, requiring reliable positioning information. Research and development on the concept of Intelligent Speed Adaptation is going on both regarding speed limits and dynamically changing limits due to the prevailing conditions. Some systems are based on the Active accelerator pedal. The Active accelerator pedal provides a counter-force whenever the driver tries to depress it beyond a pre-set speed limit.

---

**11.- RUNFLAT INDICATOR/ TIRE PRESSURE MONITORING SYSTEM**
**Classification:** Primary Safety / Passenger Cars / Drive Safe

**Description:** In case of an air loss in a tyre the system gives a warning to the driver.
1. The Deflation Detection System detects any loss of pressure through the wheel speed sensors, that cause a specific alteration of the speed signal due to changes in the radius of the tire.
2. In case of a tire pressure monitoring system the air pressure in each tyre is directly measured and displayed if necessary.

---

**12.- REAL TIME TRAFFIC INFORMATION SYSTEM**

**Classification:** Primary Safety / Road / Drive Safe

**Description:** This is information to the driver about the traffic (congestion) and weather conditions for choosing the most effective route or for preparing to cope with the foreseeable situation ahead on the route.

Important is the actuality of the information about the traffic situation, to maintain the credibility of the function. The information is transmitted to in-vehicle and nomadic devices. Short-term forecasting is essential for these systems. Information can be personalised.

---

**13.- PRE-CRASH SYSTEMS**

**Classification:** Primary Safety / Passenger Cars / Drive Safe

**Description:** The system can anticipate to the upcoming crash event. It adapts safety systems to individual occupants features and real crash circumstances. A combination of systems for collision avoidance and damage mitigation will integrate the Pre-crash systems.

The Pre-crash Sensor uses millimeter-wave radar to sense vehicles and obstacles on the road ahead, and an Electronic Control Unit (ECU) to determine whether or not a collision is imminent based on the position, speed and traveling course of the object.

The Pre-crash actions are all those actions that activate before the crash, just in the moment the vehicle determines the accident can not be avoided. Such actions are as closing the sun roof or moving the seats to the optimum position.

This system may be combined with a occupant position detection system that is intended to detect occupant position in case of an upcoming crash. The information can be used to de-power or de-activate airbags if they can not be safely fired due to an out-of-position occupant.
### 4.1.5 Rescue

<table>
<thead>
<tr>
<th>14.- e-CALL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Classification:</strong> Tertiary Safety / Passenger Cars / Rescue</td>
</tr>
<tr>
<td><strong>Description:</strong> e-Call is an emergency call either generated manually by vehicle occupants or automatically via activation of in-vehicle sensors when an accident occurs. e-Call is an emergency service, which is based on precise satellite positioning and additional information of vehicles involved in a severe accident. When activated, the in-vehicle e-Call system establishes a 112-voice connection directly with the relevant PSAP (Public Service Answering Point). At the same time, a minimum set of data-including key information about the accident such as time, location, and vehicle description- is sent to the PSAP.</td>
</tr>
</tbody>
</table>
4.2 Analysis of the main systems

### RUNFLAT INDICATOR/ TIRE PRESSURE MONITORING SYSTEM

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>General Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>In case of an air loss in a tyre the system gives a warning to the driver.</td>
<td>Classification: Primary Safety</td>
</tr>
</tbody>
</table>

#### INTERVENTION DURING DRIVING

<table>
<thead>
<tr>
<th></th>
<th>ON/OFF CONTROL</th>
<th>INCIDENT/OBSTACLE DETECTION</th>
<th>ACTIVE AREAS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No</td>
<td>No</td>
<td>All Roads</td>
</tr>
</tbody>
</table>

**Motion**: Alerts the driver when a tyre runs with low pressure.

**INCIDENT/OBSTACLE DETECTION**

**POSSIBLE FAILURES**

**SYSTEM UPDATE**

### COLLISION AVOIDANCE SYSTEM

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>General Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radar system which detects/predicts the formation of dangerous situations with for example other vehicles and warns the driver.</td>
<td>Classification: Primary Safety</td>
</tr>
</tbody>
</table>

#### INTERVENTION DURING DRIVING

<table>
<thead>
<tr>
<th></th>
<th>ON/OFF CONTROL</th>
<th>INCIDENT/OBSTACLE DETECTION</th>
<th>ACTIVE AREAS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes, possible to switch-off totally</td>
<td>Yes, detects various obstacles moving or stationary</td>
<td>All Roads</td>
</tr>
</tbody>
</table>

**Motion**: Warns/Alerts the driver of dangerous situations.

**FUTURE**: System provides suggestions in dangerous situations.

**FUTURE**: System assumes partial control to avoid collision.

**INCIDENT/OBSTACLE DETECTION**

**POSSIBLE FAILURES**

**SYSTEM UPDATE**

#### ENVIRONMENT

- **Other Vehicles/Vulnerable Road Users**
  - Yes, interacts with Other Vehicles and Vulnerable Road Users

- **Weather/Roads**
  - Yes

- **Road Geometry**
  - Yes
### INTELLIGENT SPEED ADAPTATION (ISA)

**DESCRIPTION**

The system alerts the driver with audio and/or visual when the speed exceeds the locally valid legal speed limits.

**Classification:** Primary Safety  
**Safety Function:** Drive Safe  
**Vehicle Type:** Passenger Cars  
**Cost:**  
**Time to market:** More than 5 years

**INTERVENTION DURING DRIVING**

<table>
<thead>
<tr>
<th>ON/OFF CONTROL</th>
<th>INCIDENT/OBSTACLE DETECTION</th>
<th>ACTIVE AREAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driver has the possibility to choose between advisory mode or mandatory mode</td>
<td>No</td>
<td>Roads covered by digital road maps with speed limits.</td>
</tr>
</tbody>
</table>

**How to switch off**

- Red button (Mandatory mode) and green button (advisory mode) in the steering wheel.

**EFFICIENCY**

Systems based on infrared sensors: Not take into account vehicle trajectory. Systems based on video image processing: Trouble in bad visibility conditions (e.g. fog).

**POSSIBLE FAILURES**

- Necessary up-dated real-time Traffic Information is needed in order to up-date dynamic limits due to prevailing conditions.

**INTERACTIONS**

<table>
<thead>
<tr>
<th>Other Vehicles/Vulnerable Road Users</th>
<th>Road Geometry</th>
<th>Weather/Roads</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**ENVIRONMENT**

- Green: System switched on

**INCIDENT/OBSTACLE DETECTION**

- Informs driver by: Button in the dashboard instruments

**SYSTEM UPDATE**

- This system can act automatically adapting vehicle speed to the limits (in Mandatory Mode)

### LANE KEEP ASSISTANT / LANE DEPARTURE WARNING

**DESCRIPTION**

The Lane Departure Warning System is a new driving aid that detects unintentional lane departures at speeds of 80 kph and above. Lane Keep Assistant also apply a force over the steering wheel to aid driver to keep in the lane.

**Classification:** Primary Safety  
**Safety Function:** Drive Safe  
**Vehicle Type:** Passenger Cars  
**Cost:** 600 €  
**Time to market:** Existing

**INTERVENTION DURING DRIVING**

<table>
<thead>
<tr>
<th>ON/OFF CONTROL</th>
<th>INCIDENT/OBSTACLE DETECTION</th>
<th>ACTIVE AREAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes, possible to switch-off totally</td>
<td>No</td>
<td>All Roads</td>
</tr>
</tbody>
</table>

**How to switch off**

- Button in the dashboard instruments

**EFFICIENCY**

- Systems based on infrared sensors: Not take into account vehicle trajectory.

**POSSIBLE FAILURES**

- Systems based on video image processing: Trouble in bad visibility conditions (e.g. fog).

**INTERACTIONS**

<table>
<thead>
<tr>
<th>Other Vehicles/Vulnerable Road Users</th>
<th>Road Geometry</th>
<th>Weather/Roads</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>Yes, with road markings</td>
<td>No</td>
</tr>
</tbody>
</table>

**ENVIRONMENT**

- Green: System switched on

**INCIDENT/OBSTACLE DETECTION**

- Informs driver by: Button in the dashboard instruments
### Advanced Adaptive Cruise Control

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>General Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>This system regulates the speed of cruise and it controls automatically the safety distance with regard to the car that is circulated ahead</td>
<td>Classification: Primary Safety</td>
</tr>
</tbody>
</table>

1. The system regulates the cruise speed.
2. ACC system is a relatively new technology. With the help of a system of radar it controls of automatic form the safety distance with the car that circulates ahead, stopping the vehicle if it is necessary. It uses a system of radar for this reason the weather does not affect it.
3. The system of detection of traffic signs by means of cameras is other of the functions of the advanced ACC. It warns the driver of the maximum allowed speed.
4. Through to the system of images recognition, it detects exactly form the edges that delimit the rails.
5. It has a system of control speed in curve, which if it acts together with a navigation system, adapts the speed to the tracing curve.

<table>
<thead>
<tr>
<th>INTERVENTION DURING DRIVING</th>
<th>ON/OFF CONTROL</th>
<th>INCIDENT/OBSTACLE DETECTION</th>
<th>ACTIVE AREAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brake the vehicle for keeping the safety distance situations. Warns/Alerts the driver of dangerous situations.</td>
<td>Yes, possible to switch-off totally</td>
<td>Yes, detects various obstacles moving or stationary</td>
<td>All Roads</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>INTERACTIONS</th>
<th>ENVIRONMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other Vehicles/Vulnerable Road Users</td>
<td>Weather/Roads Road Geometry</td>
</tr>
</tbody>
</table>

Yes, interacts with Other Vehicles and Vulnerable Road Users  Yes  Yes

<table>
<thead>
<tr>
<th>EFFICIENCY</th>
<th>POSSIBLE FAILURES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switch in the dashboard instruments</td>
<td>On closed curves is it not sure that the system works correctly</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>INFORMS DRIVER BY:</th>
<th>AUTOMATIC BRAKING</th>
<th>SYSTEM UPDATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>By means of a sound or vibration of the steering wheel if one leaves the path by means of voice and by means of a symbol in the dashboard about maximum allowed speed.</td>
<td>Yes, ACC brakes automatically to keep the safety distance and to avoid an accident.</td>
<td></td>
</tr>
</tbody>
</table>

### Traffic Sign Recognition and Alert

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>General Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>The system detects and classifies the traffic signs in traffic scene images acquired from a moving car.</td>
<td>Classification: Primary Safety</td>
</tr>
</tbody>
</table>

1. The system incorporates a digital display that informs the driver of all the respectively applicable road signs along the motorway. The image processing system is most effective in areas where traffic signs or traffic lights have only been installed or are in operation temporarily - for example, at construction site or on highway bridges equipped with electronic signs that change according to the traffic situation.
2. In the future, they can be part of a fully automated vehicle.
3. The system can also be tied in with the adaptive cruise control, in which case the car will speed up or slow down to match changes in the speed limit.

<table>
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<tr>
<th>INTERVENTION DURING DRIVING</th>
<th>ON/OFF CONTROL</th>
<th>INCIDENT/OBSTACLE DETECTION</th>
<th>ACTIVE AREAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alerts the driver about the traffic signs along the motorway. It can be a support to automatically send a warning signal indicating overspeed, warn illegal manoeuvres or indicate earlier to the driver the presence of the sign. The system can also be tied in with the adaptive cruise control, in which case the car will speed up or slow down to match changes in the speed limit.</td>
<td>No</td>
<td>All roads</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EFFICIENCY</th>
<th>POSSIBLE FAILURES</th>
</tr>
</thead>
<tbody>
<tr>
<td>How to switch off</td>
<td>The driver chooses to comply with the warnings or ignore them</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>INFORMS DRIVER BY:</th>
<th>AUTOMATIC BRAKING</th>
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</thead>
<tbody>
<tr>
<td>Yes, detects various obstacles moving or stationary</td>
<td>Recognition of overlooked traffic signs</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>INTERACTIONS</th>
<th>ENVIRONMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other Vehicles/Vulnerable Road Users</td>
<td>Weather/Roads Road Geometry</td>
</tr>
</tbody>
</table>

No  Yes  No
### Alcohol Interlocks

**Description:** Alcohol interlocks are devices that require the driver to take a breath test before starting the car.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Safety Function</th>
<th>Vehicle Type</th>
<th>Cost</th>
<th>Time to market</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Safety</td>
<td>Drive Safe</td>
<td>Passenger Cars, Transport Trucks, Coaches</td>
<td>€1500</td>
<td>Existing</td>
</tr>
</tbody>
</table>

1. The alcohol interlock is a breath testing device connected to the ignition system of a motor vehicle. It prevents an operator from starting the vehicle if the breath alcohol concentration (BAC) exceeds a predetermined threshold or fail level.
2. The use of Breath Alcohol Ignition Interlock Devices is embedded in a program of monitoring and servicing, sometimes complemented with medical and/or psychological interventions.

### Pre-Crash Systems

**Description:** The system can anticipate to the upcoming crash event. It adapts safety systems to individual occupants features and real crash circumstances. A combination of systems for collision avoidance and damage mitigation will integrate the Pre-crash systems.

The Pre-crash Sensor uses millimeter-wave radar to sense vehicles and obstacles on the road ahead, and an Electronic Control Unit (ECU) to determine whether or not a collision is imminent based on the position, speed and traveling course of the object. The Pre-crash actions are all those actions that activate before the crash, just in the moment the vehicle determines the accident can not be avoided. Such actions are as closing the sun roof or moving the seats to the optimum position.

This system may be combined with a occupant position detection system that is intended to detect occupant position in case of an upcoming crash. The information can be used to de-power or de-activate airbags if they can not be safely fired due to an out-of-position occupant.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Safety Function</th>
<th>Vehicle Type</th>
<th>Cost</th>
<th>Time to market</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secondary Safety</td>
<td>Drive Safe</td>
<td>Passenger Cars</td>
<td>Depends on the incorporated devices: Lexus, €3400</td>
<td>Existing</td>
</tr>
</tbody>
</table>

### Interventions During Driving

**ON/OFF Control:**

- It is not allowed to switch off the device
- How to switch off
- Because the device is built-in, a driver who uses the car will have to use the alcohol interlock

**Active Areas:**

- All Roads
- EFFICIENCY
- POSSIBLE FAILURES
- Another person could pass the breath test, allowing a driver with a high breath alcohol concentration to operate the vehicle

### Environment

**Interactions:**

- Other Vehicles/Vulnerable Road Users
- Weather/Roads
- Road Geometry
- No
- No
- No

**Informs driver by:**

- AUTOMATIC BRAKING
- SYSTEM UPDATE

- Every 30 days for devices with semiconductor sensors. Six months for devices with an electrochemical measurement system
### PEDESTRIAN PROTECTION

**DESCRIPTION**

Passive systems that sense a human impact and initiate systems like external airbags or the lifting of the bonnet.

A newly developed pedestrian airbag deploys from the base of the A-Pillars in order to ensure protection to the head in a crash. Active Bonnet systems serve to prevent severe injuries and fatalities in pedestrian impacts caused by head-contact with rigid engine surfaces. Sensors in the vehicle bumper can differentiate between a human leg and a lamppost; sending a signal which raises the rear half of the bonnet through two steel bellows. This allows the pedestrians’ head to impact this raised and therefore more energy absorbent surface, reducing the chances of fatality and injury.

**INTERVENTION DURING DRIVING**

The system raises the automobile’s bonnet instantly when a pedestrian is hit; the system, which is activated by a sensor system placed on the vehicle’s front bumpers, allows the pedestrian’s head to come into contact with a softer, more flexible surface, thus limiting fatal head injuries. The system blows up the airbag after the detection of the human impact. The sensor is so accurate that it can differentiate between a lamp post and a human leg.

**INTERACTIONS**

- Other Vehicles/Vulnerable Road Users: Yes
- Weather/Roads: No
- Road Geometry: No

**ENVIRONMENT**

N/A

**INCIDENT/OBSTACLE DETECTION**

System limitations in terms of liability (always the driver is responsible and can take relevant decisions).

**POSSIBLE FAILURES**

- Biofidelity of the pedestrian dummies used to develop it
- The sensor must be accurate enough to differentiate a human leg

**GENERAL CHARACTERISTICS**

- Classification: Secondary Safety
- Safety Function: Drive Safe
- Vehicle Type: Pedestrians
- Cost: N/A
- Time to market: Existing (Citroen C6, active bonnet)

### DRIVER DROWSINESS DETECTION/DRIVER CONDITION MONITORING

**DESCRIPTION**

By monitoring the eyes, it is believed that the symptoms of driver fatigue can be detected early enough to avoid a car accident.

There are some ways of detecting drowsiness, but they are based in eyes closure. One way is a video system that detects the eyes of the driver and measures directly the eye closure. Another way is a neural network model used to estimate the eye closure using measures associated with lane keeping, steering wheel movements and lateral acceleration of the vehicle. The warnings begin as the driver becomes fatigued and intensify as the system detects increasing drowsiness, providing the driver with the opportunity for countermeasures such as napping or getting a cup of coffee before they endanger himself and/or others.

**INTERVENTION DURING DRIVING**

- ON/OFF CONTROL: N/A
- INCIDENT/OBSTACLE DETECTION: No
- ACTIVE AREAS: All roads

**INTERACTIONS**

- Other Vehicles/Vulnerable Road Users: No
- Weather/Roads: No
- Road Geometry: No

**ENVIRONMENT**

N/A

**INCIDENT/OBSTACLE DETECTION**

The warnings can begin as the driver becomes fatigued and intensify as the system detects increasing drowsiness, providing the driver with the opportunity for countermeasures such as napping or getting a cup of coffee before they endanger himself and/or others.

**GENERAL CHARACTERISTICS**

- Classification: Primary Safety
- Safety Function: Drive Safe
- Vehicle Type: Passenger Cars
- Cost: N/A
- Time to market: N/A
**BRAKING ASSIST SYSTEM**

**DESCRIPTION**
The Predictive Brake Assist (PBA) is the first safety system that in advance processes the relevant information from the vehicle’s surroundings and reacts before the impending accident actually takes place.

Using the data from the Adaptive Cruise Control’s radar sensor, PBA detects dangerous situations and in which emergency braking will be needed. If such a dangerous situation does occur, PBA prepares the brake system in advance for panic braking. Pilot pressure is applied to the brake system so that the relevant brake pressure can be generated more quickly, and the brakes are applied very gently so that the driver doesn’t notice. In addition PBA lowers the triggering threshold for the hydraulic brake-assist system in three stages. As soon as the driver reacts and hits the brakes, the full braking effect becomes available milliseconds earlier thanks to the measures that have already been initiated.

**Classification:** Primary Safety  
**Safety Function:** Braking system  
**Vehicle Type:** Passenger Cars  
**Cost:** N/A  
**Time to market:** Existing

<table>
<thead>
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<tbody>
<tr>
<td>PBA, in dangerous situations, prepares the brake system in advance for panic braking. Pilot pressure is applied to the brake system so that the required brake pressure can be generated more quickly, and the brakes are applied very gently so that the driver doesn’t notice. In addition PBA lowers the triggering threshold for the hydraulic brake-assist system in three stages. As soon as the driver reacts and hits the brakes, the full braking effect becomes available milliseconds earlier thanks to the measures that have already been initiated.</td>
<td>Yes</td>
<td>All roads</td>
<td></td>
</tr>
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</table>

**ENVIRONMENT**

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<tr>
<th>Other Vehicles/Vulnerable Road Users</th>
<th>Weather/Roads</th>
<th>Road Geometry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes, using the data from the Adaptive Cruise Control’s radar sensor.</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

**INTERACTIONS**

**ELECTRONIC STABILITY CONTROL**

**DESCRIPTION**
Safety system that recognizes unstable driving conditions at the very outset and applies corrective action. ESP helps the driver overcome critical situations and keep his vehicle safely under control.

ESP continuously evaluates the measured data from numerous sensors and compares the driver’s input with the actual behaviour of the vehicle. If an unstable condition develops – such as a sudden evasive manoeuvre - within a fraction of a second, ESP intervenes via engine electronics and the brake system to help stabilize the vehicle.

**Classification:** Primary Safety  
**Safety Function:** Handling/ Kinematics  
**Vehicle Type:** Passenger Cars/ Heavy Vehicles  
**Cost:** About 600 €  
**Time to market:** Existing

<table>
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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>If the front wheels of an under-steered vehicle drift outward, braking applied to the rear wheel on the inside of the curve develops a compensating yaw moment which returns the vehicle to the desired course again. If the vehicle threatens to over-steer with the rear of the car breaking away, braking is applied to the front wheel on the outside of the curve. The compensating moment operating in a clockwise direction turns the vehicle into the desired direction again.</td>
<td>Yes, possible to switch off totally</td>
<td>No</td>
<td>All Roads</td>
</tr>
</tbody>
</table>

**ENVIRONMENT**

<table>
<thead>
<tr>
<th>Other Vehicles/Vulnerable Road Users</th>
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<tbody>
<tr>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**INTERACTIONS**

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<tbody>
<tr>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**INFORMS driver by:**

**AUTOMATIC BRAKING**

**SYSTEM UPDATE**

Yes, over those wheels that allow to keep trajectory.
### VISION ENHANCEMENT / NIGHT VISION

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>General Characteristics</th>
</tr>
</thead>
</table>
| Assistance function that allows the driver to see at night further down the road than the headlights illuminate. | **Classification:** Primary Safety  
**Safety Function:** Visibility  
**Vehicle Type:** Passenger Cars / Heavy Vehicles  
**Cost:** 2,400 €  
**Time to market:** Existing |

The Night Vision system is an assistance function with camera techniques like infrared which enhances the perception of pedestrian and other relevant objects at night or in otherwise bad vision conditions.

#### INTERVENTION DURING DRIVING

<table>
<thead>
<tr>
<th>ON/OFF CONTROL</th>
<th>INCIDENT/OBSTACLE DETECTION</th>
<th>ACTIVE AREAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes, possible to switch-off totally</td>
<td>Improve the detection under bad vision conditions</td>
<td>All Roads</td>
</tr>
</tbody>
</table>

How to switch off:
- Button in the dashboard instruments

Objects detected as a function of their heat, therefore obstacles are worse detected than human beings or animals. Weather conditions influence in the quality of image detected.

#### INTERACTIONS

<table>
<thead>
<tr>
<th>Other Vehicles/Vulnerable Road Users</th>
<th>Weather/Roads</th>
<th>Road Geometry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes, improve the visibility of vulnerable road users</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

#### ENVIRONMENT

- Display image in the dashboard instruments or in the windshield
- No

#### EFFICIENCY

Visibility is limited to illumination range.

#### POSSIBLE FAILURES

- Objects detected as a function of their heat, therefore obstacles are worse detected than human beings or animals.
- Weather conditions influence in the quality of image detected.

### ADVANCED FRONT LIGHT SYSTEM

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>General Characteristics</th>
</tr>
</thead>
</table>
| The Advanced Front Light System improve night-time driving safety. The headlamps follow the direction in which the driver is steering. | **Classification:** Primary Safety  
**Safety Function:** Visibility  
**Vehicle Type:** Passenger Cars / Heavy Vehicles  
**Cost:** 400 €  
**Time to market:** Existing |

Concept of intelligent lighting, according to curves, weather conditions and speed. It estimates where you will be in three seconds’ time, using sensors that monitor your speed and the angle of your front wheels, and shines the car’s headlights in that direction. The left and right headlamps swivel by different amounts depending on the way the driver is turning.

#### INTERVENTION DURING DRIVING

<table>
<thead>
<tr>
<th>ON/OFF CONTROL</th>
<th>INCIDENT/OBSTACLE DETECTION</th>
<th>ACTIVE AREAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automatic</td>
<td>Improve the detection extending the illumination range in the relevants areas</td>
<td>All Roads</td>
</tr>
</tbody>
</table>

How to switch off:
- Visibility is limited to illumination range.

Informs driver by:
- Automatic braking
- System update

#### INTERACTIONS

<table>
<thead>
<tr>
<th>Other Vehicles/Vulnerable Road Users</th>
<th>Weather/Roads</th>
<th>Road Geometry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes, improve the visibility of vulnerable road users</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

#### ENVIRONMENT

- No
### e-Call

**DESCRIPTION**

e-Call is an emergency call either generated manually by vehicle occupants or automatically via activation of in-vehicle sensors when an accident occurs.

**General Characteristics**

<table>
<thead>
<tr>
<th>Classification</th>
<th>Safety Function</th>
<th>Vehicle Type</th>
<th>Cost</th>
<th>Time to market</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tertiary Safety</td>
<td>Rescue</td>
<td>Passenger Cars / Heavy Vehicles</td>
<td>1,500 €</td>
<td>Existing</td>
</tr>
</tbody>
</table>

**INTERVENTION DURING DRIVING**

The system could be activated either manually or automatically.

**INCIDENT/OBSTACLE DETECTION**

The system does not affect driving.

**ACTIVE AREAS**

No

### Active Front Steering

**DESCRIPTION**

The Active front steering system, provides more direct direction to low speed, by what it can be operated in a more agile way, whereas on having increased the speed, the direction becomes more indirect, with a quietier behavior on to drive to high speeds.

1. Active front steering is a controlled system electronically that modifies the relation of the direction in normal conditions of driving to low or average speed, achieving that it is more direct, with what applying a minor draft of the steering wheel is obtained a major draft of the wheels. On the contrary, on having driven to high speed, the direction is more indirect, with what the path is more stable and the vehicle reacts with more precision.

2. This system has turned into natural something, almost invisible for the driver.

3. The Active front steering has a system of regulation of the car draft on its vertical axis, that can be interconnected with the system Dynamic Stability Control, thus when this one tries to correct a slide or skid, the active front steering can help to restore the control of the vehicle with what the system Dynamical Control of Stability has to work later.

4. Future, It has different modalities of functioning to select for the driver.

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### Active Front Steering

**DESCRIPTION**

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<th>Other Vehicles/Vulnerable Road Users</th>
<th>Weather/Roads</th>
<th>Road Geometry</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>
The system monitors traffic approaching from behind or in the driver’s blind spot, will warn the driver if they are about to make a potentially unsafe change lanes or turn.

The same radar sensors also provide information for a safe door-opening function, warning the driver of any cyclists, people on roller-blades or vehicles approaching from behind before opening the door. Side sensing supports drivers in detecting vehicles within the “blind spot” to the rear of their own vehicle, to facilitate safe lane changes on motorways.

LCA incorporates basic blind spot monitoring, which is fundamentally a short-range sensing mode, with longer range sensing to detect vehicles in adjacent lanes, which may be rapidly approaching and could also pose a hazard in a lane change maneuver.

Recognises other road users behind and alongside the vehicle, warning the driver, with an early recognition of rapidly approaching vehicles thanks to range of up to 50 m.

In the case of an impending lane change, the lane change assistance system determines the distance and relative speed of other vehicles and generates, if necessary, an optical or acoustic warning.

Informs driver by:
- How to switch off
- It can be switched off through the car computer

In case of an existing lane change, the lane change assistance system determines the distance and relative speed of other vehicles and generates, if necessary, an optical or acoustic warning.

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Informs driver by:
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- It can be switched off through the car computer

In case of an existing lane change, the lane change assistance system determines the distance and relative speed of other vehicles and generates, if necessary, an optical or acoustic warning.
5 Conclusion

This report is a complete compilation of the main safety systems already developed by the automotive industry, as well as an introduction to the new and future products that will be developed in the next years.

On the one hand, it will allow classifying and being aware of the various systems that are installed in passenger cars, motorcycles, etc; also, it is useful to see that pedestrian safety is going to be seriously taken into consideration in the next years. On the other hand, it has the objective to serve as a guide for the end users, so that they can really know what they are buying.

In conclusion, recent technologies are making the vehicle’s users life safer, but they are often creating a distance in terms of usability between the producer and the consumer. So, this is the reason why users should begin to be informed about all these safety systems, which is the aim of this report.

After Work Package 1 has laid the foundations of the project, Work Package 2 will evaluate the actual knowledge of users about all the safety systems mentioned. Then, we will be able to establish the procedure that will allow users to become more aware of them.