GOVERNMENT STATUS REPORT, 2019
FEDERAL REPUBLIC OF GERMANY

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1. STATUS AND TRENDS

1.1. Road accidents in Germany

The total number of police registered road accidents has increased by 12 per cent since 2000 – from 2.4 to 2.6 million road accidents in 2017. In the beginning of the century slight increases were offset by slight decreases, resulting in almost the same accident figures in 2011 as in 2000. Since then the number of accidents has started to increase slightly year by year, with yearly increases between 0 and 5 percent. The forecast for 2018 also indicates a further increase in accident figures by about 1 percent.

The number of road accidents with personal injury has decreased by more than 20 % since 2000, resulting in 302,656 road accidents with personal injury in 2017. The decrease has mainly been realized from 2000 to 2009 (- 19 percent). Since then, no further substantial decrease has been noted, the figures have stagnated around 300,000 injury accidents. A slight increase is expected for 2018.

Casualty figures have also decreased since 2000, with lower reductions for slight injuries and higher reductions for severe injuries and fatalities. The total number of casualties has decreased by approximately 23 percent from 511,577 in 2000 to 393,492 in 2017. The stagnating number of injury accidents in the last years is mirrored in the stagnating number of casualties. In 2018 an increase to about 400,000 casualties is expected.

Since 2000, the number of serious injuries has been reduced by about 35 percent to 66,513 seriously injured road users in 2017 and the number of slight injuries has been reduced by more than 19 percent to 323,799 slightly injured road users. Both injury severity groups follow the same pattern: Most of the decrease has been realized until 2009/2010. In the years after, no decrease was noted for slight and serious injuries.

Fatalities have decreased by almost 58 percent from 7,503 fatalities in 2000 to 3,180 fatalities in 2017. Although a deceleration of the decrease can be noticed since 2010 fatality figures are still slowly regressing. For 2018 an increase to approximately 3,230 fatalities has been predicted. This might be the first year with an increase following two consecutive years with decreasing fatality figures.

While many factors concerning e.g. safety behavior or vehicle and infrastructure safety play an important role for the long term development of fatality and crash figures, short-term increases result mainly from changes in mobility and traffic behavior due to different and extreme weather conditions. The year 2018 was characterized by very dry and sunny weather from spring to late autumn, very likely entailing an increase in traffic of certain modes of transport associated with this kind of weather. As a result fatality figures increased especially for cyclists and riders of mopeds. Increases are also expected for children and the elderly.

1.2. Socio-economic costs due to road traffic accidents in Germany

The Federal Highway Research Institute (BASt) calculates the costs of traffic accidents on an annual basis. The costs burden of German national economy caused by traffic accidents includes costs of fatalities, injuries and damage to goods.

The socio-economic accident costs include direct costs (e.g. medical treatment, vehicle repair/replacement), indirect costs (police services, legal system, insurance administration, replacement of employees), lost potential output (including the shadow economy), lost added value of housework and voluntary work, humanitarian costs and costs of monetised travel time losses due to traffic jams caused by accidents. The mathematical model developed for the purpose of accident costs assessment enables an analysis of slight, severe and severest injuries and the effect of underreporting on total accident costs.

The total traffic accident costs amounted in 2017 to approximately 34.23 billion Euro. The costs of fatalities and injuries reached 13.19 billion Euro whereas the costs of about 21.04 billion Euro were caused by damage to goods. Comparing 2017 data with accident costs occurred 2015 (previous reporting year) we observe an 8% decrease of fatalities costs and injuries costs. However, the increase of damage to goods by 4.5% equalized the above positive effect and the total amount of accident costs was 2017 only 0.5% lower than that of 2015.

The costs per person added up to 1.150 million Euro for a fatality, 116,335 Euro for a severely injured person and 5,138 Euro for a slightly injured person.

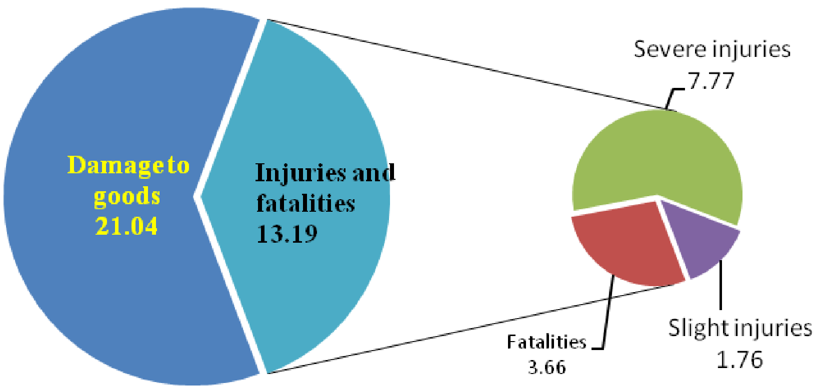

Figure 1: Costs due to road traffic accidents in 2017 (billion Euro)

1.3. German Road Safety Programme

The present German Road Safety Program was launched in autumn 2011 and will be running for ten years until 2020. The principal aim of the program is to enable safe, ecologically sensitive and sustainable mobility for all road users in Germany. It comprises a wide range of road safety measures addressing road users, vehicles and the road infrastructure.

The program addresses new challenges (e.g. demographic change and mobility of elderly) and aims at safeguarding the efficiency of the road network. At the same time, it reflects recent technological developments in vehicles such as driver assistance systems, cooperative vehicle systems or new engine concepts. In these latter areas, the main focus lies on ensuring that the development of vehicle technology induces safety gains rather than safety risks. Activities also focus on rural roads and on reducing not only the number of fatalities, but also the number of serious injuries. Work is currently underway to develop the following German Road Safety Programme.

2. RESEARCH

2.1. Finished projects

2.1.1. Turning Assist Systems for Trucks

Accidents between right turning trucks and straight riding cyclists often show massive consequences. Accident severity is much higher than in other accidents. The situation is critical especially due to the fact that, in spite of the mirrors that are mandatory for ensuring the field of view for the truck drivers, cyclists in some situations cannot be seen or are not seen by the driver. Either the cyclist is overlooked or is in a blind spot area that results from the turning manoeuvre of the truck and its articulation if it is a truck trailer or truck semitrailer combination.

Assistance systems that provide the driver with an information way before a situation becomes control are considered to be a solution. Such systems would generally bear a high potential to avoid accidents of right turning trucks and cyclists no matter if they ride on the road or on a parallel bicycle path.

BASt therefore carried out a research project in order to develop a testing method and elaborate requirements for turning assist systems for trucks. In-depth accident data was evaluated. These findings served to determine characteristic parameters (e.g. boundary conditions, trajectories of truck and cyclist, speeds during the critical situation, impact points). Based on these parameters and technical feasibility by current sensor and actuator technology, representative test scenarios and pass/fail-criteria were defined. This work has led to activities on UN ECE level, namely a working document was submitted to GRSG early 2017, which was send to an informal group for further optimization. Finally, the 115th GRSG in October 2018 adopted a proposal for a new regulation for blind spot information systems for heavy vehicles and sent it to WP.29 for further consideration in its March 2019 meeting.

2.1.2. Handbook „Accessibility in long-distance bus transport“

Accessible travel is becoming increasingly important, considering demographic change and the increasing demand for mobility by older passengers and those with restricted mobility. Since the liberalisation of bus transport in Germany, travel on long-distance buses has increased greatly. A new regulation (the passenger transport law, PBefG) came into effect on 1 January 2013. Under an agreement in the coalition contract for the 18th legislature period, the production of a handbook “Accessibility in long-distance bus transport” was foreseen, including an accessible electronic version. The intention was to prepare the handbook as an easily understandable, succinct brochure with examples of best practice for the implementation of accessibility in practice by stakeholders. The handbook thus not only covers the accessibility measures for vehicles but is also applicable to infrastructure and operation.

The research project had the objective of describing extensive accessibility for all user groups, with not just the interests of wheelchair users and people with reduced mobility being considered but also passengers with sensory, cognitive and movement limitations as well as the elderly and families with children.

The handbook was produced with significant involvement of the decisive stakeholders and shows good examples of accessibility in long-distance bus transport. It offers a guideline for the various users, vehicles manufacturers, transport provides, councils, operators of bus stations and representatives of people with disabilities in order to implement accessibility in long-distance bus transport. For this purpose the viewpoint comprised vehicles, infrastructure and operation. Only the cooperation of all three areas will enable a continuously accessible travel chain in long-distance bus transport.

The handbook "Accessibility in long-distance bus transport" was published in a printed version by the Federal Ministry of Transport and Digital Infrastructure (BMVI) as a seperate publication. The handbook was also made available in an accessible version (PDF) so that the content is available for people who are blind or poorly sighted.

2.1.3. EU project PROSPECT

BASt participated in the EU-funded Horizon 2020 project „PROSPECT“ (PROactive Safety for PEdestrians and CyclisTs). The goal of this project was to increase the overall traffic safety for pedestrians and cyclists by generating a better understanding of relevant critical scenarios and the advancement of active vehicle safety systems, such as autonomous emergency braking and evasive steering applications. On the basis of a detailed analysis of accident data from various countries, the focus for the development of prototype functions and test protocols was set to urban intersection scenarios, which are the most relevant for occurring severe injuries of vulnerable road users (VRU). The developed prototypes within this project feature innovative methods for robust and early VRU detection of pedestrians and bicyclists. The control systems use an increased radial sensor range and high performance actuators to find the optimal combination of quick steering and braking interventions. Advanced sensor interpretation systems allow to better judge the intention of pedestrians and cyclists along the vehicle path with respect to their direction of movement. For the evaluation of these prototypes, new realistic trajectories for cornering maneuvers had to be specified on the test track. Finally, the user acceptance was proved in several simulator studies to verify the high socio-economic benefit of improved future active safety systems. The derived test procedure will expand towards European consumer testing in the next years to achieve a high market penetration as soon as possible.

2.1.4. Intersection assistance (Euro NCAP)

Automatic Emergency Braking (AEB) systems increasingly offer the possibility to address even complex conflict situations, such as found in intersection traffic. Against this background, the development of novel test scenarios with regard to the requirements of consumer information and legislative procedures is of interest. Euro NCAP plans to introduce the assessment of car-to-car junction assist systems from 2020 on. One objective of a project concerning intersections is to provide substantial information on car-to-car accidents in Europe. The Use Cases identified in this context serve as a basis for the definition of representative test scenarios. Based on the official German Road Accident Statistics (Destatis), most relevant accident scenarios were derived by grouping and weighting certain accident types. Subsequently, an investigation of associated crash parameters obtained by the German In-Depth Accident Study (GIDAS) took place, which finally led to the Use Cases. Severe accidents at intersections in Europe occur most frequently at “crossings” and “t- or staggered junctions”. Although pedestrians, cyclists and motorcyclists play a dominant role within these accidents, car-to-car accidents still amount to a share of one-fifth of all severe accidents and of one-quarter of all related fatalities. The Accident Scenarios Straight Crossing Paths (SCP), Left Turn Across Path with an opponent coming from the Opposite Direction (LTAP/OD) and Left Turn Across Path with an opponent coming from the Lateral Direction (LTAP/LD) are of highest relevance. For each of these scenarios, up to six crash parameters (e. g. speed profile, turning radius, collision angle, impact point) could be evaluated. The derived test procedure can expanded towards European consumer testing in the next years to achieve a high market penetration as soon as possible.

2.1.5. Personal Light Electric Vehicles (PLEV)

The aim of this project was to determine whether and under which conditions very small electric vehicles so called Personal Light Electric Vehicles (PLEV) can be operated safely in road traffic, which technical requirements need to be satisfied and which potential conflicts with other road users are to be expected. PLEV are those vehicles without a seat such as electric kick scooters and self-balancing vehicles (e.g. similar to the Segway). They could be approved up to 2016 in accordance with the Framework Directive 2002/24/EC (Type-approval of two or three-wheel motor vehicles / category L vehicles), which is no longer in force. The new Type Approval Regulation (EU) No. 168/2013 for two or threewheel vehicles and quadricycles has been in force since 2016. However, PLEV of this type are out of the scope of this regulation. Instead the approval can be regulated at a national level. An assessment of the traffic safety of such vehicles is required on the one hand to be able to decide on whether they can be approved. On the other hand vehicle dynamics tests are needed to provide information for the classification of these vehicles and to stipulate respective requirements. In this research project, the Federal Highway Research Institute (BASt) prepared suggestions for a classification of this type of specific small electric vehicles and for the technical requirements to be placed on them so that they may be used safely in road traffic. PLEV were investigated in four sub-studies: considerations with regard to active and passive safety, user behaviour and risk assessment as well as traffic area. It emerged that it is possible to propose new categories of PLEV with certain minimum requirements. It is recommended that PLEV should comply with these requirements to be allowed to be driven in traffic. Depending on the proposed vehicle categories, corresponding traffic areas are recommended for use, based on the analysis of subjective safety and of the potential conflicts with other road users. Recommendations were also derived for (safety-related) technical equipment for the newly proposed PLEV categories. The requirements are based on those for the existing vehicle categories "light moped" and "moped".

2.1.6. Automatic Emergency Braking for Heavy Goods Vehicles

Automatic braking systems for heavy goods vehicles are mandatory across the European Union. While the requirements for pre-accident speed reduction on a moving target with 68 km/h reduction from 80 km/h are quite demanding, the required speed reduction towards a stationary target is not so strict (13 or 28 km/h from 80 km/h, depending on truck type). One major vulnerability of the current technical requirements in the AEBS regulation (UN-Regulation No. 131) is the possibility for drivers to switch the systems off (required for rare conditions where the AEBS sensors cannot interpret the environment and thus might act inappropriately) without requiring a mechanism to re-activate the AEBS at a time when the need to switch off has disappeared. The other aspect that could be optimized is that vehicle deceleration is limited during the mandatory warning phase.

BASt was carrying out a research project to investigate how an automatic re-engagement of those systems could be handled and if an adaption of the speed reduction requirements to the current state of the art might be appropriate. The findings have been delivered to the German Ministry of Transport, which then have been incorporated into a proposal to modify UN-Regulation No. 131 in the following aspects:

- Collisions between heavy vehicles and stationary targets should be avoided up to driving speeds of 70 km/h; the brake strategy should not drastically change for higher driving speeds.
- Driver warnings should not be mandatory anymore in favor of automatic brake intervention for low relative speeds.
- It should not be possible anymore to deactivate AEBS systems at driving speeds above 30 km/h, and systems should automatically reactivate.

Germany's modification proposal is currently in discussion between interested contracting parties and the Industry; delivery of a consensus proposal is aimed for by autumn 2019.

2.1.7. KO-HAF

From 2015 to the end of 2018, a research project concerning cooperative, Level 3 driving (Ko-HAF) was performed. BASt joined a national consortium with automobile and electronics manufacturers, suppliers, communication technology and software companies, research institutes and road administration. The project aimed at the development of cooperative, Level 3 driving on motorways, i.e. for high speed ranges on well constructed road infrastructure. This included a significant improvement of forecasts for environmental detection in addition to the automation of the longitudinal and lateral control of vehicles. Key activities of BASt – in an academic part – was the definition and specification of relevant data on traffic and road conditions to be stored in the backend, the evaluation of usability of external data for the use cases of Level 3 driving, the design of data exchange with third parties and the evaluation of data protection issues. Based on this, BASt supported the development of highly accurate maps acting as an expanded forecast for automated driving. Furthermore, the driver cannot be taken entirely out of the loop during Level 3-driving. Therefore, the resumption of the driving task by the human driver within a certain lead time was also subject to research in Ko-HAF. Several test vehicles were constructed for testing and demonstration of highly automated driving under normal conditions and in case of system failure. The new vehicle operation took place on test tracks and on public roads.

In a practical part, BASt conducted a first driving test to classify the effect of driver’s vigilance and fatigue in a Level 2 drive when permanent monitoring of an automated driving function is necessary over long time intervals. Participants were driven in a 'Wizard of Oz' vehicle, meanwhile fatigue measurements were performed by using psycho-physiological data, e.g. EEG (electroencephalography) as well as behavioral data. The experiment also focused on the influence of small automation failures regarding driver’s vigilance. Typical fatigue patterns influenced by automation failures emerging in fatigue oscillations with strong individual differences were found. In a second step, the effectiveness of possible countermeasures was investigated. At this the driver was free from monitoring and should perform motivating so called “driving unrelated tasks” like texting on a smartphone or reading a book. In contrast to Level 2 driving, the Level 3 automated period showed a significant decrease in fatigue level.

2.1.8. AFAS

The project “aFAS” (“Driverless Safeguarding Vehicle for Highway Shoulder Roadworks”), was funded by the Federal Ministry of Economic Affairs and Energy. The project focussed on the goal to actually operate a safeguarding vehicle under traffic in driverless mode. As far as known, this was the very first driverless operation of a vehicle in Germany, under traffic and without a safety driver on board. The demonstration was shown alongside the final project event in Frankfurt on the 20th June 2018. The Demonstration took place on the German Motorway “A3” near Frankfurt and under heavy (real) traffic conditions. A video of the driverless demonstration can be accessed under https://youtu.be/8BUWjRs3n_w

Figure 2: MAN Truck & Bus AG, Driverless demonstration of the safeguarding vehicle following on the German Motorway, aFAS press-release, 20th June 2018

The overall focus of the project was on the reduction of risks for workers driving safeguarding vehicles today. During operation the maximum speed of the vehicle was limited to 10 kph (~6 mph) which is the average speed required for roadworks by the vehicle in front (for cleaning, grass cuttings etc.). The safeguarding vehicle is intended to be driven manually up to the place of work where the automation is activated so that no driver is needed within the domain (SAE J3016 Standard version 06/2018; Level 4: driverless within a specific operational design domain, without any expectation that a user will respond to a request to intervene.). The safeguarding vehicle was connected via Wifi to the leading vehicle and relied on a sensor system for safety.

The development of the safety concept required for the driverless application under traffic was the most challenging part. It needed to be ensured that the automated, driverless vehicle would by no means leave the hard shoulder and head into the traffic passing by (being the most critical scenario) to be examined closely. This key aspect was implemented by means of a reliable sensor system able to detect the road marking and activating an immediate emergency stop in this specific case (as minimal risk or safe state on the hard shoulder). This was technically implemented by designing an independent second “safety-path” completely separated from the vehicle control system. Within safety-design the standard ISO 26262 was considered as guideline and reference for the safety-relevant design. BASt was involved in the identification of the legal aspects of driverless implementation and legal inconsistencies in the application of the ISO-Standard 26262 against the background of Road Traffic Regulations and liability.

2.1.9. SENIORS

The efforts put the last years in road safety derived to a reduction of almost 48% of total fatalities in Europe, and the number of elderly fatalities due to road accidents has also decreased. However, among all the road fatalities, the proportion of elderly is steadily increasing. Considering these statistics and the expected demographic change in our society, the SENIORS project (Safety ENhanced Innovations for Older Road users) funded by the European Commission (GA No. 636136) and coordinated by BASt aimed at providing the needed knowledge and enabling the suitable tools to reduce the number of elderly fatalities and serious injuries suffered in road traffic accidents. The project runtime was from June 2015 to May 2018 (www.seniors-project.eu).

This project primarily investigated and assessed the injury reduction in road traffic crashes that can be achieved through innovative and suitable tools, test and assessment procedures, as well as safety systems in the area of passive vehicle safety. The goal was to reduce the numbers of fatally and seriously injured older road users for both major groups car occupants and external road users (pedestrians, cyclists) by enhancing the introduction of advanced safety systems through the implementation of assessment tools for elderly protection based on PMHS studies, volunteer testing and accident data. The research covered topics such as crash, hospital and behavioural data analysis, biomechanics, the development of test tools, procedures, and assessments. Further, to gain required data, tests with volunteers and with post-mortem human subjects are carried out, sled and impactor tests were conducted and numerical human body model simulations were performed. BASt was deeply involved in nearly all of these technical activities.

Accident data analysis showed that elderly car occupants have a higher risk of injury than younger occupants in particular in the thorax area even in accidents at lower velocities of 30 to 40 kilometers per hour. This issue was addressed within the SENIORS project by various approaches. Improved chest injury criteria for the frontal impact dummy THOR were developed. A new simulation-based approach making use of comparative computer simulations of a human model and a THOR dummy model were applied. The injury criteria for the dummy were thus optimized in the area relevant for older road users. SENIORS proposed the introduction of advanced chest injury criteria and a reduced-impact frontal impact test in new frontal impact test and assessment procedures. Sled tests have shown that these proposals can demonstrate benefits of advanced occupant restraint systems - such as adaptive systems and four-point harnesses - and thus provide improved protection in particular for older occupants.

Based on current injury patterns of pedestrians and cyclists, the vulnerable road user (VRU) safety branch of SENIORS, mainly driven by BASt, proposed modifications to the state-of-the-art pedestrian test and assessment procedures described in legislation and consumer programmes. Human body model (HBM) simulations with MAthematical DYnamic MOdels (MADYMO), replicating the most relevant motor vehicle to cyclist accident scenarios concluded in an extension of the pedestrian head impact zone and modified test parameters towards a combined VRU test procedure. FE simulations with the Total HUman body Model for Safety (THUMS) were used as input for test parameters within the scope of new test and assessment procedures, where a prototyped thorax injury prediction tool (TIPT) was tested against vehicle frontends for the first time. An upper body mass (UBM), representing the pedestrian's torso was applied to the lower legform impactor FlexPLI, improving its injury assessment ability particularly in the femur area and its applicability for high vehicle frontends and against angled surfaces, combing the upper legform to WAD775 and the upper (or lower) legform to bumper test within one single test.

2.1.10. Adoption of UN-GTR9-PH2

With its last meeting in December 2017, the United Nations Informal Working Group on the development of Phase 2 of the Global Technical Regulation on Pedestrian Safety (GTR9-PH2), chaired by Germany, concluded its work related to the introduction of the flexible pedestrian legform impactor (FlexPLI) alongside the definition of injury assessment reference values (IARVs) and the extension of the vehicle bumper test area (BTA); however the modified headform test could not be included. GRSP endorsed the proposal in May 2018 and AC.3 considered and voted for the Amendment 2 to UN-GTR9 during its November 2018 session.

2.1.11. CODECS

Communication of vehicles directly amongst each other and with road infrastructure enables a plethora of information and warning services for a safe, sustainable and comfortable future mobility. These services require new cooperation between private and public sector in order to provide seamless experience for the end user. The issues to be tackles jointly have very different nature ranging from fundamental technical and organisational aspects to legal concerns. Therefore lively exchange between the new collaboration partners is essential. In order to support this and to foster C-ITS deployment in Europe, CODECS (COoperative ITS DEployment Coordination Support) was set up as a nodal point for the various involved stakeholder groups. The Horizon

2020 support action (36 months, 05/2015 – 04/2018) has facilitated the C-ITS deployment coordination activities on European scale.

The CODECS consortium, consisting of road operators, car manufacturers, automotive industry experts as well as user and cities representatives, aimed at pooling the main actors' preferences and requirements for a concerted C-ITS roll-out across Europe. As starting point, in the inventory phase numerous pilots, deployment initiatives and private key stakeholders were brought together and the current plans, concepts and ideas were gathered. Numerous documents were analysed and several workshops organised. The experiences of this knowledge exchange and the constant survey of the C-ITS landscape in Europe were used in the consolidation phase to come up with guidelines and recommendations. The CODECS activities complemented the EC activities like the C-ITS Platform. The harmonisation activities within the project and in the workshops can be seen as precursor of the C-Roads platform which is harmonising specifications and deployment activities within 16 European countries today. CODECS has held its final event at TRA 2018 in Vienna. The heritage of CODECS (Deliverables, workshop documentations etc.) has taken on board of the Amsterdam Group website.

2.2. Ongoing and planned research

2.2.1. Safety potential and testing of reversing assistants for passengers cars (M1) and LGV´s (N1)

To increase the active and passive safety of motor vehicles and also for stylistic reasons, it can be observed that the pillars in vehicle design (A-, B-, C-, D-pillar) were constructed more massive over the years. Next to the advantages in terms of the integrity of the passenger compartment and the torsional stiffness of the vehicle, this measure may also have disadvantages in relation to the driver's field of vision.
Accidents while reversing are often pure material damage accidents when manoeuvring. However, accidents involving personal injury are also reported, e.g. with approaching cyclists while backing out from the driveway or running over children who are behind the vehicle.

Reversing assistance systems (for example radar sensors with acoustic and / or optical display, rear-view cameras, etc.) have been installed in motor vehicles for a number of years and are also frequently retrofitted. These are advertised in particular for the avoidance of property damage accidents or for the ease of manoeuvring. In principle, however, they also have the potential to prevent accidents involving personal injury. At present, however, there are no uniform requirements for such systems that would be necessary in order to generally estimate their safety potential. This is why BASt assigned a study to examine the safety potential and possible test methods for reversing assistance.

When it comes to accidents with reversing vehicles mostly pedestrians and cyclists are injured according to the GIDAS database. These generally move at an angle of approximately 90° to the reversing vehicle.
The analysis of the development of the rearward field of view of various vehicle models confirms the decline of the visual conditions out of the vehicle since the 1970s.
Observations of the view strategies when reversing showed that the available reversing display systems in vehicles are not always used.

In order to configure a test method, the today installed systems were subjected to a benchmark test. For this purpose, ultrasonic sensors were first tested by moving three different test bodies in the direction of the rear end of the vehicle. In doing so the various warning levels were determined and compared. In order to test radar systems, a moving pedestrian dummy was used. In order to test existing camera systems, a standardized dummy was equipped with a scale and placed behind the vehicle. The detection area of the camera was then explored.

Based on an analysis of the systems potential using pre-crash matrix simulations of 200 GIDAS reversing collisions, the quality of the back-up assistance system to avoid accidents with injuries could be evaluated.

2.2.2. Study on winter tires

Winter tire use is mandatory in Germany if there is snow or ice on the road. Commercial vehicles (N1, N2, M2 and M3) are required to have tires with winter characteristics at least fitted to their driven axles due to the current national regulation.

Theoretical considerations suggest that specific winter tires on steering axles might contribute to better braking behavior of commercial vehicles. The steering axle has a large influence on empty truck-and-trailer combinations, while the effect is expected to be lower for fully laden vehicles. The current regulation on tires UN-R 117 specifies requirements for traction tires, but not for steering axle tires. Currently available steering axle winter tires therefore are tested according to these requirements.

Therefore, BASt was asked to compare the performance of winter tires and summer tires that are designed for use on steering axles. Experiments were carried out on prepared snow tracks in northern Europe; the project is expected to finish by Summer 2019.

2.2.3. Automatic Emergency Braking for passenger cars

Automatic braking systems for passenger cars, designed to address car accidents with other cars, pedestrians and / or (to some extent) bicyclists are state of the art and already available in various production vehicles. It is expected that those systems will have a significant effect in improving traffic safety, so the European

Commission has included them in their proposal for the new "General Safety Regulation". The preferred way of setting requirements for technical systems is a broad international discussion on UN ECE level, so the European Commission together with Japan initiated an informal working group with the goal of setting agreed requirements for automatic emergency braking systems for N1/M1 vehicles.

Germany was part of that group and contributed with calculations, simulations as well as experimental data. Finally, the group agreed that AEBS systems should be able to avoid accidents up to a driving speed of 42 km/h on stationary targets and pedestrians and deliver a comparable performance for slow moving targets. These results have been delivered to UN ECE in January 2019 and are expected to be formerly adopted in June this year. The European Commission currently plans to make these systems mandatory in steps and beginning from 2022 (for new types).
Further work is concentrated on developing appropriate requirements for AEB systems also addressing bicycle accidents.

2.2.4. Motorcyclist-friendly safety barriers

Road restraint systems, which offer improved protection for motorcyclists in addition to the protection of vehicle occupants, should comply with the Technical Specification CEN/TS 1317-8:2012 "Motorcycle road restraint systems" published in 2012. In the beginning of 2000 when the systems for motorcyclist protection have been developed and tested in Germany there was no European standard for testing. Since it is now uncertain whether the original systems also meet the requirements of this new specification, this question will be investigated in an ongoing research project. For this purpose, impact tests are carried out on the original and if necessary a modified system (Figure 3). On basis of the results of these impact tests, recommendations for use will then be developed, which will conclude the research project by the end of 2019. The results can be used directly in practice to retrofit existing road restraint systems. This will adapt the systems to the current state of the art and will help to reduce the consequences of an accident of a motorcyclist with a road restraint system.

Figure 3: Impact according CEN/TS 1317-8:2012 (source: DEKRA)

Up to now, the assessment of the sharpness of construction elements in road restraint systems, especially with regard to the impact of motorcyclists, has been rather subjective. In a further research project, therefore, specific indications for the definition of system-neutral sharp-edged construction elements road restraint systems are to be determined. Here, impact tests were carried out with a new type of biofidelic crash test dummy, modeled on humans, on variants of individual construction parts. Initial impact tests (Figure 4) have shown enormous differences in the injury potential of individual construction elements. The impact parameters were derived on basis of an accident analysis and also on CEN/TS 1317-8:2012. Objective criteria for the evaluation of sharp edged construction elements will be developed. In practice, this makes it possible to distinguish between dangerous and less dangerous systems and to achieve a frequent use of good-natured systems. In addition, the results are to be incorporated into national and international regulations or guidelines as well as into European standardization.

Figure 4: Biofidelic crash test dummy at impact point (sigma post covered with a pipe)

2.2.5. Active motorcycle safety

Motorcycle riders are still one of the most endangered groups in modern traffic. Due to the specific driving dynamics of one-track vehicles and the location of the predominantly driven roads, the severity of accidents tends to be considerably above average. Analyses of available accidentology data in the past showed that the cause for a typical accident with a motorcycle on rural roads is loss of control over the vehicle. Prevention of mistakes by the rider in relation to occurring roll angles and braking while cornering are promising starting points for a reduction in motorcycle accidents on rural roads.

To increase the traffic safety for motorcycle riders, BASt conducts own research as well as supervising several external research projects on various topics related to motorcycle safety. Recently, braking in curves is a challenging scenario addressed by the motorcycle industry. Since there are no public studies available evaluating the benefits of the current systems, BASt claims to provide an overview of the potentials for traffic safety including user acceptance. Options for future rider trainings are to be assessed. The comparison of objective and subjective assessment can also serve as a basis for the performance and the limits of future AEB motorcycle safety systems. The currently ongoing research aims to identify boundaries that are set by rider limits (e. g max. longitudinal deceleration or rider acceptance) in which AEB systems could provide a safety benefit. In terms of riding dynamics, it is important that the rider is able to stabilize the vehicle at any time. With the current research roadmap BASt aims to further promote the development of innovative safety systems in motorcycles, which actively support the rider in critical situations.

2.2.6. EU-Project PIONEERS

PIONEERS (Protective Innovations Of New Equipment for Enhanced Rider Safety) updates the current test methods and standards for personal protective equipment for riders and on-board systems.
The main pillars of PIONEERS are to achieve a deep understanding of the injuries sustained by PTW (Powered Two Wheeler) users, improve the performance of safety systems (Personal Protective Equipment, PPEs, and on-board systems), to develop better test and assessment methods and to increase the use rate of PPE.

The improved performance will be achieved by understanding the most safety-critical accident scenarios and impact conditions to reach a higher level of understanding on how the injuries occur and by developing more reliable, realistic and robust test methods. An increased use will be fulfilled by listening to the riders' needs, improving the systems in terms of comfort (without compromising safety) and carrying out active awareness raising and dissemination actions. The main goal of the PIONEERS project is to improve the safety of PTWs by providing an integrated approach to rider protection considering on-rider (PPE) and on-board systems. Therefore, this project will investigate and assess the direct contribution to the reduction of fatalities and the severity of injuries, as well as the number of injured PTW users. The tools for that are developing new PPEs and on-board safety systems, as well as improving the validation and assessment methods and increasing the usage rate of such devices. Developing high-quality products (PPEs and on-board systems) from the European manufacturers and sensitizing the PTW users for the enhanced safety potential of those products will not only increase the safety level for PTW users but will also strengthen European competitiveness.

Finally, the main results of PIONEERS will be: (i) higher understanding of injuries suffered by the riders (ii) better testing methods enabling better performance assessment and (iii) better products (PPEs and on-board systems) achieving an increased safety level for PTW users.

BASt participates in this project by delivering and analysing accident data with the focus on body regions addressed by different elements of PPE. Furthermore BASt will develop test methods to assess helmets and neck protectors. Especially the test method for helmets will consider the current knowledge on head injury mechanisms and will be used to support the update of helmet requirements during the revision of the UNECE-R 22.

2.2.7. Friction prediction

Precise knowledge of the friction potential is of great importance for safe longitudinal and lateral control of a car. This potential is influenced by many parameters like weather conditions, road surface and tyres. While today it is the driver who assesses friction values, it will be necessary for future highly automated vehicles to independently obtain information on environmental conditions. A cause-based estimation procedure for estimating the maximum friction coefficient has been developed which relies solely on information that is available without additional vehicle sensors. This information consists of data which is present in the vehicle itself, such as outside temperature, vehicle speed or rain intensity and on data provided by the surrounding infrastructure. This includes weather data from weather stations or information on road conditions obtained from road weather information systems. By combining and integrating these fields of information, the range of the maximum coefficient of friction is established using the estimation procedure developed in the project. The result of a huge number of test brakes is a comprehensive database with more than 5,000 data sets which includes for each full braking manoeuvre more than 80 parameter information about weather, road state etc. Based on these data the mentioned friction estimation algorithm was developed. Detailed analysis of the data sets of single braking points should help to understand under which circumstances the friction coefficient changes. The evaluation of the estimation algorithm showed, that it provides satisfactory results even if some information are not available.

For the future it is imaginable that numerical weather simulation models, which give detailed weather information and which also consider local effects of the vegetation can improve the friction estimation a lot. Additionally, the use of vehicle dynamic parameters like wheel speed and interventions of ABS and ESP might improve the estimation algorithm.

2.2.8. Bus safety: smoke gas toxicity

Despite that busses are one of the safest means for transport, singular accidents and especially fire events with and without connection to an accidents can become very severe. Vehicle regulations for busses have been adjusted to address various aspects of fire safety, e.g. by introducing fire detection and control systems and burning behavior tests.

One aspect that has not yet been regulated is the smoke gas toxicity. Several standards with specific advantages and disadvantages from other modes of transport exist, but it is unclear which of those standards could best be adopted towards busses.

The focus of an upcoming research project, funded by BASt, will be the investigation of appropriate requirements for bus material smoke gas toxicity and the development of a corresponding, probably more efficient test procedure.

2.2.9. HMI aspects on Camera-Monitor-Systems

Since June 2016 conventional outside and inside rear-view mirrors can be replaced by Camera-Monitor-Systems to present views of the traffic situation behind the vehicle to the driver. At that time the corresponding UN Regulation No. 46 "Uniform provisions concerning the approval of devices for indirect vision and of motor vehicles with regard to the installation of these devices" entered into force.

Based on a previous BASt-study (F112b; Camera-Monitor systems as a replacement for exterior mirrors in cars and trucks) and UN Regulation No. 46 BASt has started a follow-up project which focuses on specific human machine interaction aspects. On the one hand, different display positions (peripheral, central in front of the driver and in the center of the vehicle – according to height variations in accordance with UN-R 46) should be investigated in terms of perceptional speed, discrimination possibilities and human's (direct) view. On the other hand, the effects of merged presentations of backward information on human's perception are explored. Besides that, the project focuses on human's perception of distances and velocities at high differential velocities in a real driving scenario. This project will terminate end of 2019.

2.2.10. Activities with regard to UN R 22 and helmets for S-Pedelecs

Within the frame of the UNECE/GRSP Informal Working Group for Protective Helmets the revision of the UNECE-R 22 has started. The update will include the test methods and test parameters to further extend the protective effects of motorcycle helmets. The new test methods will take tangential impacts and rotational kinematics of head and brain into account to enable an assessment of helmets under more realistic loading conditions. Beside the test method the use of a more advanced headform and the consideration of relevant injury criteria will contribute to helmets with higher protection in the future.
So far, the assessment of motorcycle helmets was mainly focused on linear impacts and excluded the rotational effects of impacts during real accidents associated with brain injuries.
Based on a previous BASt research project to identify the potential optimization of motorcycle helmets BASt will contribute to the working group by promoting and discussing the results.

With the continuing trend towards the electrification of mobility the safety of S-Pedelecs has to be considered. One important aspect is the use of personal protective equipment by the riders of S-Pedelecs. Since these vehicles are classified as motor vehicles (L1e) the use of suitable protective helmets is mandatory in Germany. Current requirements for suitable helmets are defined within the UNECE-R 22 for motorcycle helmets. As motorcycle helmets are made for higher speeds and low physical activity of the rider, the ventilation and mass of current motorcycle helmets are not seen optimal for the use on S-Pedelecs.
BASt compared the protective as well as the comfort related requirements defined in different standards and regulations for helmets. Tests showed that the protective effect of UNECE-R 22 compliant helmets is higher then of helmets for bicycles (EN 1078) and S-Pedelecs (NTA 8776). Since the comfort related characteristics (e.g. ventilation) are not defined or restricted in any of the relevant standards, the optimization of motorcycle helmets is seen as a solution to provide suitable and safe helmets for the use on S-Pedelecs.

2.2.11. Seriously injured road accident casualties

So far, the German Road Traffic Accident Statistics have defined "seriously injured" as those casualties who are treated in a hospital as in-patients and survive for at least 30 days. According to the new common European definition, seriously injured road-users are casualties with an injury severity classified as MAIS3+, i.e. injuries of the maximum abbreviated injury severity of level {3, 4, 5, 6}, and who do not die within 30 days from the effects of the accident. The abbreviated injury scale (AIS) is an anatomical-based coding system that classifies the injury severity by the AIS severity score on a six-point ordinal scale indicating risk for death.

The working group developed methods to determine the number of seriously injured road accident casualties in Germany on the basis of established data sources. The projections were based on the German In-depth Accident Study (GIDAS) and the TraumaRegister of the German Trauma Society® (TraumaRegister DGU®). The applied projection approaches are described in detail and their limitations are discussed. Though GIDAS and the TraumaRegister DGU® have basically different aims (crash analyses versus quality management in hospitals), both databases produce comparable results: the total number of serious injuries in Germany in the year 2015 is 15.442 resp. 14.370 persons. It must be assumed that also in coming years projections are the sole way to determine the number of serious injuries in Germany, as there is no golden standard meaning no nationwide assessment of injured road users according to the new definition.

2.2.12. UNECE IWG on Deployable Pedestrian Protection Systems (Active bonnets)

The UNECE-GRSP Task Force on Deployable Pedestrian Protection Systems (TF-DPPS), chaired by the Republic of Korea, experienced an upgrade to an Informal Working Group in 2018 with the aim to interest a higher number of contracting parties to the 1998 agreement in the development of an amendment to UN-GTR9, implementing a test procedure for deployable bonnets. BASt emphasized the need for active systems providing at least the same level of protection to vulnerable road users as passive systems, to be ensured by a set of prerequisites prior to impactor testing. Due to very controversial discussions, BASt organized a subgroup of interested parties for developing a common understanding in what needs to be addressed by this IWG. Consensus was found regarding the principal need of DPPS capability to detect pedestrians, to ensure a certain protection level at speeds below the deployment threshold and to provide a correct timing of the system. No agreement was found with respect to the need for pedestrian protection at higher speeds and the actual protection level of active bonnets. The group continues working on further outstanding topics such as an adequate surrogate for the hardest to detect pedestrian and the legitimacy of human body model simulations within UN regulations. The current schedule foresees an adoption of Amendment 4 to UN-GTR9 by AC.3 in June 2020.

2.2.13. GIDAS – new requirements to address new vehicle technology

In summer 1999, a cooperation between FAT (Research Association of Automotive Technology) and BASt (Federal Highway Research Institute) started the German In-Depth Accident Study (GIDAS) which is one of the largest in-depth accident data collections, recording more about 3,500 parameters per crash. Since then vehicles, objectives in road traffic policies and consequently research questions have changed. While the enhancement of passive vehicle safety has been the main objective during the start of GIDAS, requirements to modern field data collections change to gathering crucial information about pre-crash maneuvers and vehicle equipment with respect to crash avoidance technologies.

In modern vehicles, driver assistance functions are increasingly supporting the driver in complex or dangerous situations by applying preventive strategies. These strategies include warnings, enhanced braking assistance, and automatic interventions to increase road safety. A key challenge is to quantitatively assess the safety performance in terms of reduction or mitigation of traffic crashes, as these real-life effects are key considerations for all stakeholders involved in the planning of future mobility. Crash re-simulation and stochastic traffic simulation provide large opportunities to predict these effects. Both approaches require widely recognized models and reliable simulation. Hence, in order to agree on validity and reproducibility, the overall method, from the combined use of heterogeneous data sources in modeling to simulation metrics must be transparent.

Virtual “what-if” re-simulation based on reconstructed crash trajectories may show if a system had affected particular crashes on a case-by-case basis. However, reconstruction relies on limited traces and does not cover the complete traffic situation. But stochastic traffic simulation based on accident data can model how conflicts emerge and how to avoid or mitigate them. The GIDAS consortium supports such activities.

Further, GIDAS will investigate how electronic data recording systems (e.g., EDR) of vehicles which had an accident could be accessed in a larger scale considering the latest data protection laws. By this, the pre-crash and crash phase could be assessed much better than today and in particular in the cases of automatic system interventions. In addition, this forms one basis to be prepared for investigating future accidents involving (highly) automated vehicles.

Note: GIDAS is celebrating its 20th birthday now in 2019.

2.2.14. Human Body Modelling

The relevance of Human Body Models (HBMs) in vehicle safety research is significantly increasing for various reasons. On the hand HBMs are an important research tool for evaluation and improvement of dummies and test experimental tools as well as the respective injury assessment criteria. In the future HBMs might also be directly used for vehicle safety assessment complimentary to experimental based test and assessment procedures. Therefore HBMs are meanwhile used by BASt for various internal and cooperative research studies.

For example within the EU funded project SENIORS HBM simulations were used to develop updated dummy based chest injury criteria to achieve improve injury assessment methods for elderly car occupants. A new simulations based approach was proposed by BASt together with project partners, which makes use of HBM and dummy simulations. To consider age related particularities of elderly car occupant an updated HBM was used for this method taking into account the morphologies differences of an elderly rib cage. The model was developed within the SENIORS project and implemented into the THUMS human model. Based on first promising results BASt will continue to further improve this HBM simulation based approach to further improve injury assessment criteria.

Another part of SENIORS focused on external road users in which an improved legform impactor with upper body mass (FlexPLI-UBM) and a thorax injury prediction tool (TIPT) were developed mainly based on HBM simulations. Corresponding HBM and impactor simulations were conducted against several actual vehicles and rigs, representing different frontends (Sedan, SUV, Sportscar, MPV). Based on this work impactor prototypes have been developed within SENIORS. Further studies have shown a significantly improved biofidelity of the newly developed FlexPLI-UBM compared to the current FlexPLI. In the next step BASt will extend the biofidelity studies to finalize the development.

In accidents with highly automated vehicles new accident scenarios and new occupant seating positions will be expected. For these new accident conditions current physical test tools like dummies might not be applicable anymore for safety assessment. This will require new simulation based test procedures including human body models. Some of the question related to this will be addressed by BASt in the EU project OSCCAR.

Furthermore, a prerequisite for the potential future use of HBMs in virtual testing procedures will be harmonized HBM validation requirements and application methods. Therefore, BASt continues to support the THUMS User Community (TUC). Within the TUC all project partners are working closely together to archive these goals.

2.2.15. Child Safety at the UNECE with regard to R 129

Within the frame of the UNECE/GRSP Informal Working Group for Child Restraint Systems the work on the third phase for the development of the new regulation on enhanced child restraint systems was finalized. In this third phase, integral child restraint systems, connected to the car by using the vehicle belt system, are included in UN R 129. The proposal was agreed in June 2018 by WP 29, entering into force on the 29. December 2018.

The UN R 129 now includes Integral ISOFIX Enhanced Child Restraint Systems (i-Size and specific vehicle), Non-integral Enhanced Child Restraint Systems (i-Size and specific vehicle booster seat) and Integral Belted Enhanced Child Restraint Systems (universal and specific vehicle). For all Enhanced Child Restraint Systems according to UN R 129 a stature based system depending on the standing height of the child is used. All i-Size CRS will fit on an i-Size labeled vehicle seat.

For the time being only boosters without backrest are not included in UN R 129. A task force of interested experts was asked by GRSP to streamline discussions on draft amendments to the UN R 129, especially with regard to booster cushions. The works of the UNECE/GRSP Informal Group “Child Safety” as well as the task force are supported by BASt.

2.2.16. Development of requirements on automated driving functions for vehicle regulations

Automated driving functions are supposed to be available and to be used in vehicles to a greater extend. The development from the pure driver assistance to higher automation of single driving functions is an evolutionary process with a crucial step to be executed at the moment: The driver can be released in some dedicated parts of the road traffic of his obligation to perform driving task because the vehicle is supposed to be able to take over this task in some defined areas completely. This challenge has to be met both technologically and from the legislator. First changes for technical vehicle regulations on UNECE level were implemented in the UN-Regulation No. 79 for continuously assisted steering functions. The responsible Informal Working Group, chaired by Germany and Japan, which revised UN-Regulation No. 79 regarding automated steering functions (ACSF = Automatically Commanded Steering Functions), now, after requirements for corrective and emergency steering have been established, has the task to develop technical requirements for higher levels of automation (automated lane keeping system (hands-off) for highway applications, e.g. low speed/ traffic jam situations). There are big challenges of the technical requirements on automated steering without the continuous surveillance of the driving task by the driver to be overcome. Reliable safety systems shall be installed and present in the vehicle when automated steering is allowed to be activated and the driver is not any longer obliged to have the hands on the steering wheel and the eyes on the road. In this case the braking system is also of special importance because in case of transferring complete driving task to the vehicle, the longitudinal control with speed and distance control has to be transferred as well. If during the automated driving phase a sudden and unexpected situation occurs the system shall be able to cope with the situation by itself e.g. by emergency braking. There is a qualitative difference to today's emergency braking systems where normally a warning phase leads to the braking phase and where the systems have to incorporate a possible driver reaction like steering to avoid a crash. In terms of safety a very important issue to decide on is the transition procedure of the driving task from the automated system back to manual driving to ensure at any time a 'driver' is in control of the vehicle.

2.2.17. EU-Project L3-Pilot

In the project "L3Pilot", 34 partners from research, industry and government agencies cooperate in order to test the safety, efficiency and usability of automated cars (SAE levels 3 and 4). BASt participates with a study on user acceptance and trust, and provides input to the safety impact assessment. The project is co-funded by the European Union under the Horizon 2020 programme.

To understand the attitude of drivers towards automated vehicles, it is crucial to examine their trust and acceptance with respect to these technologies. Too much trust can cause misuse, too little trust or acceptance can hinder the use of automated driving functions and thus their positive effects on road safety and efficiency. In L3Pilot, BASt will perform a long-term study with a research vehicle in real motorway traffic in order to investigate participants' trust, acceptance and secondary task engagement and their change over time. The results will show if e.g. gender or age of drivers affects trust and acceptance and if the participants are willing to use the automated riving function for a longer trip.

In the project methods for different fields of evaluation are developed. BASt participates in defining the methods for the impact assessment particularly having a look at implications for safety (accidents with injured casualties) and the scaling up of the results to EU level. The verification of those methods is another important part to make sure plans are feasible to implement. In a top-down approach the proposed methodologies will be checked with respect to the information flow from the intended response to the research questions and also with respect to the outputs and inputs to the processing of indicators and the logging of data.

In contrast to existing projects, the impact assessment in L3Pilot will be based on real world (pilot) data which are complemented with other sources where necessary. GIDAS is a source that will be used to determine the possible effect of the L3Pilot systems.

2.2.18. Development of evaluation methods for driver interaction with assistance and automation (national research and Euro NCAP)

Safety of continuously automated functions strongly depend on and result from successful driver-vehicle-interaction. In short term, this effect is particularly strong in case of already available parallel automation as provided by SAE Level 2 (L2) Systems. Per definition, any L2 system performs both the lateral and longitudinal vehicle motion control with the expectation that the driver completes the Object and Event Detection and Response (OEDR). Nevertheless, every system performs also parts of the OEDR itself, for example providing steering torque if lane markings indicate curvature. This amount of OEDR performed by the system and the expectation that the driver completes the remainder of OEDR varies between different L2 systems. Especially highly reliable L2 systems performing a greater amount of OEDR while at the same time requiring only little driver input over time can make it difficult for drivers to correctly identify their role and responsibility. Based on international standards, literature reviews and expert consultations, a first checklist-based expert-evaluation for currently available vehicles with L2 systems was developed. Assessments are focusing on different sources of user information (e.g. user manual), human-machine-interface design as well as the prevention of unintended use by different driver monitoring techniques. The checklist-tool was developed in cooperation with experts and validated in a common expert workshop to gain high level of standardization and agreement. Besides the assessment of these rather explicit forms of information design criteria, also implicit forms of driver-vehicle-interaction, for example vehicle dynamics or system behavior and reliability within different situations and contexts (e.g. how strong is the steering wheel resisting input of human driver when the system is active), play an important role. Therefore, it is intended that further assessments also include observational and interview measures of user studies. To ensure a holistic assessment, the methodological aim is to take also interaction related processes regarding user´s understanding of roles and responsibilities when applying automated driving functions as well as user´s awareness of automation modes or traffic situations into account. Based on the results of the development of evaluation methods for assistant functions (L2), further methods and categories for the assessment of higher level automated functions (Level 3 and above) will be developed soon.

2.2.19. EU-Project OSCCAR

The EU project "OSCCAR - Future Occupant Safety for Crashes in Cars" - is dedicated to the improvement and assessment of vehicle safety for car occupants in future accidents involving highly automated vehicles. Highly automated vehicles might enable new, more comfortable seating positions (swivel seats and reclined positions). Furthermore, collisions with highly automated vehicles might also lead to new accident scenarios and thus load condition of vehicle occupants. To continue to protect all passengers in the best possible way, innovative occupant restraint systems (belts, airbags and new seating concepts) will be required.

OSCCAR aims to develop protection principles for these new innovative restraint systems. Furthermore, conventional crash test dummies might not be suitable for the design and evaluation of these new protection systems, especially in new impact scenarios. A possible alternative approach could be the use of human body models. These virtual test tools, which can also represent different road user types in terms of anthropometry and age, could be a possible solution in a process of virtual testing. The further development and improvement of these virtual test and development tools is one main objective of OSCCAR. A new virtual test and assessment method involving human body models will also require a validation procedure for the vehicle environment including new restraint systems. The development of this procedure is one main task of BASt within the OSCCAR project.

2.2.20. PEGASUS

PEGASUS (**p**roject for the **e**stablishment of **g**enerally **a**ccepted quality criteria, tools and methods as well as **s**cenarios and **s**ituations for the release of SAE Level 3 driving functions) develops tools and procedures for the testing and homologation of automated vehicles. The 17 project partners from science and industry fields define a state-of-the-art technology for the safeguarding of Level 3 driving and demonstrate the development in a practical manner, using the example of the ‘highway chauffeur’ until midyear 2019. The objective is to develop a procedure for the testing of automated driving functions, in order to facilitate the rapid implementation of automated driving into practice.

In a practical study BASt focuses on the identification of risks that can arise in the interaction between a highly automated vehicle and the driver. In a field study performed on highways, the influence of traffic density on the driver's takeover capability will first be examined. The driving tests should uncover possible safety risks during transitions and enable an initial assessment of the influence of the traffic situation. In a second study, a test site will be used to investigate effects of a preceding automated drive on the ability to cope with unexpected situations following the successful completion of the takeover request. Both empirical studies use the BASt 'Wizard of Oz' vehicle which is able to simulate the considered automated driving functions.

2.2.21. Development of basic scenarios for the description of control-relevant requirements for continuous automated vehicle guidance

In order to assess and quantify the safety performance of continuously automated vehicles – and thereby assuring their safe deployment into the vehicle fleet - relevant testing procedures have to be developed. Such testing procedures have to be able to reflect realistic traffic scenarios, in particular focusing on critical, accident prone situations. Furthermore they have to provide ways to challenge Level 3 automated vehicle systems with complex situations and environmental conditions which can notably tempt their sensory and decision making abilities. Presently various attempts to establish such testing procedures are primarily based on the selection and appropriate parameterization of traffic scenarios, which are either derived from real world traffic recordings (e.g. NDS, FOTs or In-Depth accident investigations) or generated synthetically.

Testing scenarios can provide a basis for deriving either laboratory track driving tests or can be translated into virtual testing environments for simulation based driving tests. Both techniques will require performance criteria as well; however simple “no crash” criteria might not be sufficient to fully express necessary requirements.
The research project PEGASUS, promoted by the German Ministry of Economic Affairs and Energy, has developed a showcase to demonstrate a complete step-by-step procedure of a scenario based assessment and

validation of Level 3 automated vehicle functions by focusing on the example of the “Highway chauffeur function”. The results of the project can serve as a blueprint for the further development of any scenario based validation approach and shall thereby also enhance associated international co-operation.

2.2.22. EU project HEADSTART

BASt participates in the EU-funded Horizon 2020 project „HEADSTART” (Harmonised European Solutions for Testing Automated Road Transport). The HEADSTART project will define testing and validation procedures of Connected and Automated Driving (CAD) functions including its key enabling technologies (i.e. communications, cyber-security, positioning) by cross-linking of all test instances such as simulation, proving ground and real world field tests to validate safety and security performance according to the needs of key user groups (technology developers, consumer testing groups and type approval authorities).
Five major objectives encompass the HEADSTART project:
Create a dynamic catalogue of existing methodologies, procedures, tools for testing, validation and certification considering multi-stakeholder requirements. Harmonisation of existing testing and validation approaches taking into account other industries and domains. Define and develop test, validation and certification methodologies and procedures for CAD functions building upon existing initiatives. Demonstrate the developed methodologies, procedures and tools through the testing of four CAD use cases (to be defined within the project). Reach consensus by creating and managing an expert network of CAD testing to promote adoption of the project results considering multistakeholder needs.

HEADSTART brings together a large representation of stakeholders across the value chain leveraging the knowledge from European and national activities on CAD testing. The consortium and associated stakeholders will cluster the most relevant initiatives, develop the specific procedures and tools missing and harmonise the whole approach to reach a harmonised European solution for testing, validating and certifying automated road vehicles. This will be achieved by international cooperation with industry, academia and policy makers participating in dedicated working groups of a managed expert network during the whole project duration.

2.2.23. C-Roads Germany

The European Commission has published its C-ITS strategy (COM (2016) 766) in November 2016 which heavily builds on the results of the C-ITS Platform (first phase). C-Roads, as a family of deployment pilots for C-ITS services, is seen from this perspective as the most important, infrastructure related, element of practical pre-deployment throughout the EU. The C-Roads Platform started with eight Member States and doubled this number to 16 in the meantime. Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Hungary, Italy, the Netherlands, Norway, Portugal, Slovenia, Spain, Sweden and UK jointly work on harmonising specifications and the necessary measures for a Europe-wide deployment of C-ITS with seamless experience for the end user.

Together they mobilise approx. 199 Mn EUR (thereof 107 Mn EUR co-funded by Connecting Europe Facility) of infrastructure investment in C-ITS services. The investments complements the huge efforts of the automotive industry incl. their suppliers to kick start mass market deployment of C-ITS services in the vehicle fleet by 2019. C-Roads has been officially launched in Brussels in December 2016 (see Figure 8). C-Roads Germany ties together the pilots in Hesse (Rhine Main region) and Lower Saxony (around Braunschweig and Wolfsburg). It is a 10 Mn pilot running until 2020 with the overarching goal of providing interoperable, safety and efficiency targeting C-ITS services. The BASt roles are devoted to the national technical coordination of C-Roads Germany and the provision of coordinated expert input into the various expert groups (addressing issues to be solved for deployment, i.e. organisational issues, security, service harmonisation, infrastructure communication, hybrid communication, validation, evaluation and assessment of the pilots) of the C-Roads Platform. Especially, BASt chairs the task force on security aspects and co-chairs the task forces on hybrid communication and on validation. BASt also supports the Federal Ministry of Transport and Digital Infrastructure in the Steering Committee representation.

As first important results, C-Roads has released the Harmonised C-ITS Specifications for services with infrastructure involvement in Europe which have been included in the Delegated Act on C-ITS (Draft Delegated Act published for Public Consultation on 11.01.2019)). Furthermore, reports on legal and organisational structures as well as on the European security mechanism for C-ITS have been published.

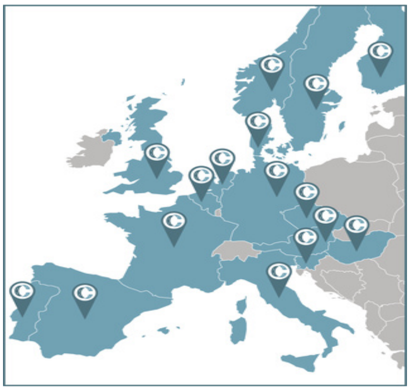

Figure 5: Official launch of C-Roads by EU Commissioner Bulc on 12th December 2016 in Brussels ©EC.

Perspectively, the C-Roads Platform will further grow as a result of projects funded from the CEF Call Transport 2018. This will enlarge the number of cooperating Member States to approximately 20. Even more important is the inclusion of urban C-ITS services into the C-Roads programme. Like several other Member States, Germany has submitted a proposal “C-Roads Germany Urban Nodes” which includes pilots in Hamburg, Kassel and Dresden. The co-funding decision is expected for spring 2019.

2.2.24. Practical Test for the Quality of Congestion-Tail Information

The overall objective of this activity is to reduce the number of end-of-congestion accidents, by providing on-time and accurate warnings on occurring congestion-tails to road travellers. Corresponding information can be nowadays acquired by commercial traffic-data providers, which generate such information from movement patterns of connected road users. Such data seem to offer a good alternative or supplement to conventional detection by road authorities, e.g. via cameras or manual reporting.

However, minimum requirements for such third-party-generated congestion-tail information, as well as framework conditions for their procurement by the public sector, must be defined in advance.

So far, a concept study is available on corresponding minimum requirements and a testing approach (FE 82.0637/2015 "Minimum Requirements for Congestion-Tail Information and Concept for their Practical Testing"). This study suggests an implementation of a practical test to validate the conceptual approaches.
The follow-up project "Concept and Monitoring of a Practical Test for the Quality of Congestion-Tail Information" (FE 03.563/2017)) has been initiated in January 2019. It includes the implementation and evaluation of a test in real-world environment during at least 6 months. During this test, data from different, commercial traffic-data providers will be assessed; and suitable quality assessment criteria will be defined. As a goal, public road authorities will receive guidance in assessing and procuring commercially available congestion-tail information, through e.g. calls for tenders.

The test is planned to start in summer 2019. A final report, including the test evaluation and guidance documents for road authorities, is expected for summer 2020.

2.2.25. Research program road safety

BASt has the task to carry out purposeful planning and coordination of research in the area of road safety and to examine traffic safety improvements.

For this reason BASt elaborates an annual research program, which addresses specific and anticipated safety deficits in road traffic in order to provide scientifically sound information as a base for advice and support of the Federal Ministry of Transport and Digital Infrastructure (BMVI). For example safety of pedestrians in urban areas was the main topic in the 2017 research program road safety, Safety Performance Indicators will be evaluated in the 2019 program.