The Ministry of Enterprise and Innovation is responsible for road traffic safety in Sweden. But due to the decentralised structure in Sweden, the Ministry works with budget, goals, and policy related issues while the operations are managed by the **Swedish Transport Administration** based on the directions from the ministry. The administration is responsible for the planning of the entire transport system with all modes of transport. It is also responsible for the building and maintenance of roads and railroads. The Swedish Transport Administration, also has an overarching role in the development of long term strategies and plans for all modes of transport in the transport system, contributing to the goals set up by the government for the transport sector. The Transport Administration holds responsibility for research within the fields of mobility, environment and traffic safety. It is also performing in-depth studies of fatal crashes within the road traffic system. If co-operation with other actors in society is necessary to effectively achieve its goals the Administration may work together with these actors.

The other authority in the sector is the **Swedish Transport Agency** which has overall responsibility for regulations within air, sea, rail road and road traffic. Within the Swedish Transport Agency the Road and Railway Department formulates regulations, examines and grants permits, as well as exercise supervision within the field of road transport over e.g. road traffic, vehicles, driving licences and commercial transport. The agency also conducts analyses of road traffic and supply information about injuries and accidents within the road transport system. Swedish Transport Agency is also maintains vehicle and driver licence registers.

The Swedish Transport Administration and the Swedish Transport Agency are both responsible to work towards the transport policy goals.

In Sweden the main other bodies active in road traffic safety efforts are the police, the local authorities and the vehicle importers association. Other important parties are the NGOs for example the National Society for Road Safety (NTF), with its member organisations, and transport industry organisations. The Group for National Road Safety Co-operation (GNS) is a central body that coordinates the co-operation between the Swedish Transport Administration and Agency, the local authorities the authority for occupational health and safety and the police. The NTF is an additional member of this group, as well as some other key partners from the traffic safety sector.

**ROAD TRAFFIC FATALITIES**

The Swedish overarching long-term safety objective within the road transport system was settled in 1997 (now twenty years ago), when the Swedish parliament voted for the “Vision Zero”. This vision states that ultimately no one should be killed or seriously injured in the road transport system (Johansson, 2009). The design and function of the system should be adapted to the conditions required to meet this goal.

Since Sweden introduced a visionary goal in the middle of the 1990s several jurisdictions have taken the same approach. In some jurisdictions the name has been changed to Safe Systems Approach to avoid the strong focus on the number zero (OECD, 2008, ITF 2016).

In 2016 the Ministry of Enterprise and Innovation have made a renewed commitment to Vision Zero (Swedish Government, 2016a). In conjunction with this the Swedish Transport Administration got a strengthened responsibility for co-ordination of the traffic safety activities in Sweden.

The Commission of the European Communities has in its White Paper on transports set out the goal “By 2050, move close to zero fatalities in road transport. In line with this goal, the EU aims at halving road casualties by between 2010 and 2020. Make sure
that the EU is a world leader in safety and security of transport in all modes of transport” (EC, 2011. Page 10).

Sweden as member of the European Union was part of the union’s target of a 50% reduction of fatalities between 2001 and 2010. For Sweden that target meant a maximum 271 fatalities year 2010.

In the year 2010 the number of fatalities in Sweden was 266. The road toll in Sweden thus did reach the 50% EU target for 2010. Great progress was also made in other countries in the EU.

With significantly less than 300 fatalities per year Sweden is one of the safest countries when it comes to road traffic, with a level of 2.6 fatalities per 100,000 inhabitants in 2015. This is about half of the European Union risk average (5.2 fatalities per 100,000 inhabitants year 2015). In Sweden fatalities related to distance travelled is 3.4 fatalities per billion vehicles-kilometres (2014) which can be compared with the 6.7 fatalities per billion vehicle kilometres (2014) in USA (IRTAD 2016).

Since 2010 the reduction of fatalities is not on the same level as for the years 2000-2010. The stagnation is most apparent for passenger car fatalities on rural roads. One explanation could be the economic upturn which is supported by the fact that the stagnation is a reality also in the rest of EU and in the US. However, there is reason to believe that what we see may be the beginning of a long-term trend due to fewer infrastructural improvements than before.

![Figure 1. Road fatalities per 100 000 inhabitants in Sweden 1950-2016](image1)

![Figure 2. Road fatalities in Sweden 2002 to 2016](image2)
Sweden has a long tradition in setting quantitative road traffic safety targets. In 2009 the Swedish government stated a target of 50% reduction of fatalities and 25% reduction of severe injuries from 2007 to 2020. This target would demand Sweden to be at a maximum of 220 fatalities in the year 2020. This interim target towards the Vision Zero is a part of an updated continuing road safety operation in collaboration with other stakeholders (The Group for National Road Safety Co-operation, GNS).

After Sweden decided on a target for 2020 the European Union has decided on a 50% fatality reduction between 2010 and 2020.

The current Swedish road safety operation is based on a system of management by objectives. This system is based on cooperation between stakeholders, targets on Safety Performance Indicators (SPI:s), and annual result conferences where road safety developments and targets are followed up. The aim is to create long-term and systematic road safety operation together with the other stakeholders.

In 2016 the interim road safety target for 2020 together with the road SPI:s was revised and proposed to the Swedish Government by the Swedish Transport Administration (STA, 2016). The revised road SPI:s that are monitored is speed compliance, sober driving, seat belt use, helmet use, safe vehicles, correct motorcycles use, safe national roads, safe crossings for vulnerable road users, maintenance standard on bicycle path streets and ISO 39001 - Road traffic safety (RTS) management systems. Most of these indicators each have a target for 2020 which makes it possible to prioritize between measures easier for stakeholders.

One important element in the revision was to predict the benefits of planned interventions for road safety in order to estimate the number of fatalities in 2020. But also to facilitate the prioritisation of future road safety measures to reach midterm and long term road safety targets. It was estimated that the number of road fatalities would be reduced with approximately 16 percent from 2014 to 2020 with the current planned interventions for this period. The main part of the reduction originated from the gradual replacement of the vehicle fleet.

The role of the vehicles to contribute to the target is further discussed later in this paper. However, it is worth noticing that the replacement of the car fleet gave the biggest contribution to the results 2010 and in the near future. But even though the replacement of vehicles will continue to improve road safety significantly it has been estimated to not be enough to reach the 2020 target.

In 2016 the Swedish Government expressed a new focus on the Vision Zero and an intensified effort for road safety in Sweden. The government commissioned the Swedish Transport Administration to be the lead agency for road safety and the Swedish Government Agency for transport policy analysis to present a new proposal for interim road safety targets beyond 2020 as a response to the UN Global Goals for Sustainable Development (Swedish Government, 2016b).

In the spirit of the Tylösand Declaration, Sweden has been an initiator to get a new work within International Organization for Standardization (ISO). The management system standard ISO 39001 was released in 2012.

The vision of the International Management Systems Standard is:

- Elimination of death and serious injury in the road transport system is the overarching goal.
- A voluntary and complimentary tool to legislation, addressing all organizations interacting with road traffic and driven by the needs of interested parties, including market forces.
- An approach to utilize and disseminate "best practice".
- Knowledge transfer from Traffic safety experts to the intended user community of the standard.

All requirements of the International Standard are generic and are intended to be applicable to all organizations regardless of type, size, products and services provided.

In Sweden today more than 100 transport companies are certified to ISO 39001.
PENETRATION OF SOME SAFETY SYSTEMS IN SWEDEN

Electronic Stability Control (ESC) has been proven to be very effective in reducing crashes related to loss of control (Erke, 2008, Ferguson, 2007, Lie et al. 2006). A study of fatal crashes in Sweden has shown that ESC is reducing fatal loss-of-control crashes with 74% (Lie, 2012). Sweden has been world leading in getting a high degree of ESC penetration in new car sales. Now all new passenger cars were equipped with ESC. Even with this rapid introduction of ESC predictions show that in 2017 only 90% of the traffic will be performed in cars with ESC. Sweden has actively been part of Euro NCAP since the start of the organisation. Over the years since Euro NCAP started, vehicles safety performance has improve radically. Swedish Transport Administration has done an evaluation of the relation between Euro NCAP results and the risk of injury and fatality in real life crashes. The study shows a 70% fatality risk reduction between a Euro NCAP 2 star car and a 5 star car (Kullgren et al. 2010). Another Swedish study shows the relation between Euro NCAP pedestrian score and real life impairment risks for pedestrians and bicyclists (Strandroth et al. 2014). Results show that the injury severity for pedestrians and bicyclists hit by cars with three and four star pedestrian protection compared to cars with just one star was significantly reduced (24-56%) for all body regions. Regarding injuries of higher severity the reduction was most evident for head injuries. The injury reduction grows with higher levels of medical impairment and in lower impact speeds. Nowadays all new cars in Europe have seat belt reminders. Seat belt reminders are reducing the number of unbelted driver in city traffic with 80% in Europe (Lie et al. 2008). A Swedish study has shown that seat belt reminders living up to Euro NCAP’s specification is increasing seat belt use in fatal crashes with 80%. (Lie, 2012). Several studies has verified the effectiveness of low and high speed Autonomous Emergency Braking (Rizzi et al., 2014; Fildes et al., 2015; Cicchino, 2016). In the end of 2015 low speed AEB was offered as standard on 55% of the vehicles models sold in Sweden. On 15% it was offered as optional. Regarding high speed AEB it was offered as standard on 19% and optional on 31% of the models respectively. Numbers for 2016 are not yet available.

In 2016 a Swedish study was publishing as one of the first in the world to show the real life effectiveness of Lane Departure Warning (Sternlund et al., 2016). The LDW-system was concluded to contribute to a reduction of head-on and single-vehicle passenger car injury crashes with 30% (with a lower limit of 6% with CI 95%). These findings strongly supports the introduction of LDW/LKA-systems in NCAP test protocols.

THE CONTRIBUTION OF NEW VEHICLES

With a rapid development of vehicles safety there has been of interest to calculate the yearly benefit of the exchange of the vehicle fleet. With about 140 fatalities in cars every year, the exchange of slightly fewer than 7% of the vehicle fleet results in around 8 “saved” lives in 2016. Out of these about two thirds comes from the better crash protection and one third from the ESC systems. As more advanced safety systems are getting to the market bigger effects can be foreseen in the future.

ABS ON MOTORCYCLES

Anti-lock Brakes (ABS) has been proved by several studies to significantly reduce motorcycle crashes by some 20-50% depending on injury severity (Teoh, 2011; HLDI, 2009; Rizzi et al., 2009). A study on US insurance data (HLDI, 2014) also shows that the benefit with ABS was even higher in combination with Combined Brake System (CBS). As technology evolves more advanced ABS-system is expected and in 2013 Bosch introduced Motorcycle Stability Control (MSC) with enables full braking in a cornering manoeuvre.
Earlier studies have focused primarily on heavier motorcycle models. In 2014 a new study was therefore performed in order to confirm if the results applies to lighter motorcycles, i.e. scooters, as well (Rizzi et al., 2015). Results show that the effectiveness of motorcycle ABS in reducing injury crashes ranged from 24% in Italy to 29% in Spain, and 34% in Sweden. The reductions in severe and fatal crashes were even greater, at 34% in Spain and 42% in Sweden. The overall reductions of crashes involving ABS-equipped scooters (at least 250 cc) were 27% in Italy and 22% in Spain.

It was concluded that at this stage, there is more than sufficient scientific-based evidence to support the implementation of ABS on all motorcycles, even light ones.

Many stakeholders have been encouraging the fitment of ABS on new motorcycles (STA, 2012). In Sweden the fitment rate has increased from approximately 15% in 2008 to 85% in 2014. According to Bosch Corporation (2012) the installation rate in Europe for ABS in production on motorcycles with engine size larger than 250 cc has increased from 27% in 2007 to 36% in 2010. Since the European Parliament also has voted for a legislation which makes ABS mandatory for all new motorcycles over 125cc from 2016, the fitment rate is likely to increase even more in the years to come.

The continuous implementation of ABS will contribute to a motorcycle fleet with increased stability, making crashes that do occur more predictable. This can have important implications for the designers of road transport systems, i.e. future safety countermeasures should be designed with greater focus on upright crashes. Therefore, improving motorcycle stability with ABS can create the conditions for making other safety systems more effective, motorcycle crashworthiness, for instance.

A concept in that direction was developed by Rizzi (2016) as a first step towards a safe system for motorcyclists.
targeted projects and more long-term efforts which can deliver ground breaking results. The board’s duties also include promoting constructive cooperation between the various actors in the road traffic system.

The investments in FFI take place through various collaborative programmes. One is “traffic safety and automated vehicles”. Sweden is a world leader in traffic safety. The programme will contribute to the continued development of vehicles with active systems to prevent accidents as well as passive ones to mitigate the consequences of those accidents where a vehicle is involved. Initiatives have a systemic approach so as to get roads, vehicles and road-users to interact well.

IMPORTANT FIELDS FOR FURTHER RESEARCH

Many fatalities in Sweden as well as globally are related to impaired driving. As many other countries Sweden has an Alco lock programme for offenders. There is also some 100 000 Alco locks used in Sweden in trucks, buses and taxis on a voluntary basis. There are even some installations made in trams, ferries and locomotives. These Alco locks are used on an emerging market for safe transports. Both buyers of transports and suppliers have found these Alco locks attractive to ensure sober drivers. There is an ongoing technology development both in terms of new basic technologies for Alco locks and forms for a reliable and non-intrusive sobriety support systems. Alco locks are well suited to be used for quality assurance with ISO 39001.

Alcohol consumption is not the only reason for impaired driving. Often fatigue, distraction, legal and illegal drugs are also lumped into the term impaired driving. Vehicle systems that detect distraction and fatigue are out on the market. These systems are using signals from the vehicle to analyse the state and driving pattern for the driver. Already today the cars have an idea about when driving isn’t up to standards. The systems as of today have weak feed back to the driver and uses signal lamps of haptic feedback. Not far away in time the vehicle will have a good estimate of the potential impairment of the driver. The question is how a vehicle, on its own, can restrict and guide the driver into a safe driving envelope. The most evident way is to limit the speed of the vehicle and putting safety systems into a more nervous mode. This makes a potential crash avoided and less harmful. There is an evident need in society to research this field and to develop guide lines for a safe shut down sequence. Euro NCAP is looking at the possibility to include extended driver monitoring in the future rating system.

The layout of infrastructure and the properties of it are becoming important for modern safety technologies. Already today lane departure warning systems are using lane markings as a critical component. In the near future crash avoidance by steering will need even better environmental awareness from lines and other road furniture. More and more cars are reading traffic signs and speed restriction signs are used to help drivers from speeding. As identified by the European Council, there is an urgent need for better co-operation between vehicle manufacturers and suppliers, and road authorities. Rules, standards and strategies for line painting and road signs could be aligned with the properties of modern vehicle systems to better achieve good functionality and safety.

In the light of the rapid development within the field of automated cars the implication for infrastructure design must be better investigated. An efficient automated system can only be achieved through a tight co-operation between vehicle manufacturers and infrastructure providers. In Sweden the Drive Me project is a foundation for such a co-operation.

Speed management is a key element to achieve good safety. More and more countries are using speed cameras and section control to diminish illegal speeding. In Sweden more than 1000 speed cameras or as it is called in Sweden, “road safety cameras” have been put up the last years. The aim of the camera system in Sweden is to support drivers in making a safe speed choice and, through a change in speed behaviour among a large proportion of the traffic create a new social norm with respect to what is an appropriate speed (Belin et al 2010). This has generated an emerging market demand for support systems helping users not to over speed. Already many years ago nomadic Satnavs indicated the speed limit. The same approach is now entering integrated navigations systems. Some vehicle manufacturers are also using cameras to read speed signs. As an effect of the marker development the consumer crash test program Euro NCAP is today assessing Speed Assistance Systems (SAS) and is using the protocol since January 2013. A better compliance with speed limits will give significant environmental benefits through lower fuels consumption.
Although the road traffic injuries is a very complex problem a comprehensive knowledge have been developed over the years about the magnitude of the road safety problem, knowledge about important risk factors and both theoretical knowledge and practice experience about effective road safety strategies and measures. However, we are still lacking systematic knowledge about the way different public authorities, private organizations in different time periods try to tackle this major public health problem. We do not seem to have an adequate understanding and interpretation of the dynamics of the process aimed at formulating and implementing road safety polices and how sound road safety interventions are diffused in the society. Improving road safety requires knowledge about implementation processes, measures known to be effective and how and where in other sectors of society road safety aspects can be mainstreamed and partnerships built. It also requires the ability to choose the strategies and approaches that best fit the specific conditions of different countries Racioppi 2004, Belin 2012). The safety development for car users is impressive over the last decade. We have in Sweden seen a drop of in car fatalities with more than 50 %. But there is still a need to further improve. For other road users the same positive development isn’t seen. The fatalities in the group of vulnerable road users is proportionally growing. When looking at impairing injuries, pedestrians together with bicyclists have as many injuries as car users. Significant efforts are needed to reduce the number of killed and severely injured pedestrians, cyclist and motorcyclists. This will impact traffic safety work in the future, both from the road design and the vehicle perspective.

CONCLUSIONS

When it comes to traffic Sweden is one of the safest countries in the world. The Vision Zero approach has further boosted a good safety culture. The exchange of vehicles in combination with improved vehicle technology is a major contributor to achieve ambitious traffic safety targets. As more than 50% of new sales cars are sold to companies and other non-private buyers, active strategies to convince large fleet buyers to choose best safety standard is of outmost importance. Road users have a responsibility to operate within the safety limits of the road transport system where vehicle industry in its role as system designer partner can support the road user. Intelligent seat belt reminders, systems alerting drivers when speeding and alcohol starter interlocks are important systems to further develop and put on the market in large scale. The ISO 39001 management system standard for traffic safety will give organisations a possibility to work focused with traffic safety. Vehicle manufacturers and organisations responsible for infrastructure must develop better co-operations to ensure that the modern road offers a useful interface to modern vehicle technology such as lane departure warning and traffic sign recognition. A safe system is achieved when user capabilities, vehicle safety, road design and speed limits all are in harmony. A holistic perspective on road safety is under development and is important when prioritizing research efforts.

More general information is available at the following pages
http://www.trafikverket.se/eng
http://www.transportstyrelsen.se/en
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The United States....transportation safety

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National Highway Traffic Safety Administration, United States
After a steady decrease in the number of fatalities in traffic, 2015 showed an increase. Analysis showed that this increase was influenced by cyclists, with especially young and old peoples being over-represented. There are two possible causes:
1. Use of mobile devices during cycling
2. Increased use of e-bikes and speed-pedelecs

In order to bend this trend, legislation is prepared to prohibit use of mobile devices while cycling. Also, campaigns have started to inform people about the risks. For speed-pedelecs, the use of a moped helmet has become mandatory. Because the existing moped helmets are not designed for use on a speed-pedelec (poor cooling function), an alternative is developed and allowed. In addition, a test protocol is developed for Automated Emergency Braking (AEB) for cyclists. This protocol is expected to be incorporated in Euro NCAP in 2018/2020. Moreover, a EEVC study on frontal impact for child restraints has been supported.

With regard to future development the following issues are worth while mentioning:
1. National legislation has been developed in order to support experiments with automated driving including level 5 (no driver in the vehicle). The outcome of these experiments should be experience/knowledge for future legislation
2. A study will be done to find out under what conditions retrofit applications would be possible, to enhance the introduction of automated/connected functionality resulting in improved safety/environment
3. Requirements for software updates are elaborated in order to guarantee compliance with the vehicle requirements and awareness of the driver with regard to changed functionalities.
GOVERNMENT STATUS REPORT OF JAPAN

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TRENDS OF THE ROAD TRAFFIC ACCIDENTS IN JAPAN

The number of fatalities (those who died within 24 hours) resulting from traffic accidents in 2016 was 3,904. This represents a great decrease in the number of fatalities compared to the previous year. This number is about one-fourth the 16,765 fatalities in 1970, which was the year in which the number of fatalities reached its peak. In addition, the number of accidents resulting in injury or death and the number of injured persons decreased for the twelfth consecutive year in a row since 2004, when the numbers were at their worst.

However, both the number of fatalities and injured persons and the number of accidents resulting in injury remained high in 2016, as there were approximately 620,000 fatalities and injured persons, and approximately 500,000 accidents resulting in injury or death.

New targets were established: to reduce the number of fatalities to below 2,500 (those who died within 24 hours) and to below around 3,500 (those who died within 30 days) by 2020 in the Tenth Fundamental Traffic Safety Program for 2016–2020.

The road transport environment is beginning to change greatly due to the change in types of traffic accident victims reflecting the aging society and the introduction of Advanced Safety Technologies including Advanced Emergency Braking System (AEBS).

Therefore, on 24th June 2016 the Working Group on Technology and Vehicle Safety of the Council for Transport Policy of the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) reported a new target for 2020 to reduce the number of fatalities by implementing vehicle safety measures and evaluating their effect, and setting the policy for reaching the new target.
Future direction of safety measures includes the following:
I. Countermeasures for accidents involving Children and the Elderly.
II. Safety Measures for Pedestrians and Cyclists
III. Countermeasures against Serious Accidents Involving Large-Sized Vehicles
IV. Response to New Technologies such as Automatic Driving

The Four Main Pillars for promoting Vehicle Safety

I. Countermeasures for accidents involving Children and the Elderly
1. Child safety measures
Since the ways children get involved in traffic accidents vary with age group, we need to take safety measures appropriate for each age group.

【Specific Measures】
- Spread and promote safer and easier-to-use child seats conforming to ISOFIX and i-SIZE standards
- Eliminate nonconforming products (Study conformity signs, guide dealers, educate users)
- Promote proper uses of child seats and junior seats
- Reinforce/expand standards on visibility and detection around and behind the vehicle (Utilize camera monitoring systems (CMS), etc.)

Figure 2. Certification given to high performance ISOFIX Child Restraint System

2. Measures against accidents involving elderly victims
In parallel with measures to control their damage, we need to take safety measures to prevent them from being involved in traffic accidents in three directions:
(i) Measures to help elderly pedestrians or cyclists notice approaching vehicles more quickly and take safe actions, taking into account their declining cognitive and physical abilities
(ii) Measures to help drivers notice elderly pedestrians and cyclists more quickly and drive in a way friendly to them
(iii) Measures to help the vehicle avoid collision with advanced safety technologies such as AEBS.

【Specific Measures】
- Make a function to automatically light the headlamps (automatic lighting) at dusk mandatory
- Establish an occupant protection standard that takes into consideration the physical characteristics of the elderly etc.

3. Measures against accidents caused by elderly people
It is necessary to develop measures to help the vehicle, even if an elderly driver makes a mistake in operation, prevent accidents and reduce damage with built-in technologies.
II. Safety Measures for Pedestrians and Cyclists

1. Measures for pedestrians

In parallel with the enhancement of damage control measures, it is important to take safety measures to prevent collisions between vehicles and pedestrians or cyclists utilizing advanced safety technologies such as AEBS.

【Specific Measures】
- Examine the reinforcement/expansion of pedestrian protection standards (Expansion of test areas e.g. A-pillar, etc.)
- Promote the development and spread of AEBS for pedestrian (JNCAP (Daytime: 2016, Nighttime: 2018))
- Advanced lighting technologies (make automatic lighting mandatory, study making automatic high beam mandatory, evaluate the performance of variable light distribution headlamps (JNCAP))
- Promote the spread of nighttime pedestrian monitoring systems (JNCAP)
- Expand standards on visibility and detection around and behind the vehicle (utilize CMS, etc.)
- Make mandatory “vehicle approaching annunciators” on electric vehicles and HV, etc.
- Study warning sounds for large sized vehicles while turning right/left and reversing
- Promote the development of Intelligent Speed Adaptation (ISA) etc.

2. Measures for cyclists

It is necessary to verify the effectiveness of the pedestrian protection standard considering where cyclists hit their head.

【Specific Measures】
- Study a head protection standard taking into account cyclists into account
- Promote the development of AEBS assuming bumping bicycles from behind
- Understand characteristics of bicyclist behaviors utilizing dashboard camera (drive recorder), etc.
- Expand standards on visibility and detection around and behind the vehicle (utilize CMS, etc.)

III. Measures against Serious Accidents Involving Large-Sized Vehicles

Once involved in an accident, large-sized vehicles such as buses and trucks are likely to cause serious damage. So it is essential to take adequate measures such as; actively adopting advanced safety technologies available,
promoting safety measures such as ensuring the driver’s safe driving and proper operation management, enhancing the inspection and maintenance of poor maintenance vehicles.

【Specific Measures】
- Continue/expand purchase subsidy and tax exemption for trucks and buses with advanced safety technologies (AEBS, electronic stability control systems, lane departure warning systems, etc.)
- Expand standards on visibility and detection around and behind the vehicle (utilize CMS, etc.)
- Study warning sounds for large-sized vehicles while turning right/left and reversing
- Study systems detecting bicycles, etc. around the vehicle and notifying the driver of their presence
- Quicken implementation and sophistication of systems responding to driver’s anomaly
- Promote the spread of systems responding to driver’s anomaly after their commercialization (purchase aid, etc.)
- Make the installation of dashboard cameras on chartered buses mandatory
- Grant purchase aid for next-generation travel recorders, etc.
- Study measures to help chartered buses improve their passengers’ seatbelt wearing rate etc.

IV. Response to New Technologies such as Automatic Driving
Automatic driving technologies are roughly divided into two categories: "driver assistance technologies" which assume a human driver and "fully automatic driving technologies" which do not assume any human driver. It is vital, while maximizing the potential of new technologies, to prevent "new types of accidents" caused by those technologies.

Recently, in case of "driver assistance technologies" the vehicle is required to ensure that:
- The driver recognizes the state of the system at all times properly;
- The command of operation is taken over safely between the human driver and the system;
- The human driver monitors the safe driving by the system; etc.

For further advancement of driver assistance technologies and the commercialization of fully automatic driving technologies, we will need further advancement of environment recognition technologies and control technology, utilizing not only control technologies based on sensor information and digital maps sent by onboard cameras, radars, etc. and highly accurate self-location estimation technology (control of autonomous systems), but also dynamic information on traffic congestions, construction work, etc. and communication information between roads and vehicles, vehicles and vehicles, and vehicles and pedestrians, and the development of those technologies has started.

Also, with the advancement of automatic technology, it has been pointed out that we need to develop standards on measures against hacking (e-security) and the maintenance of function during usage (e-safety).
**Specific Measures**
- Develop UN regulations on Automatically Commanded Steering Function early and adopt domestic ones
- Promote cyber security measures
- Establish standards on warnings upon system failures and recording of their nature
- Improve regulations on accident records, etc. including videos
- Promote the research and development of HMI responding to advanced driver assistance technologies
- Respond to demonstration experiments on public roads aimed at fully automatic driving etc.

*Figure 4. Experiment in the Okinawa Prefecture
※Referred from the HP of National Institute of Advanced Industrial Science and Technology.*

**CONCLUSION**

Measures that are being taken in Japan have been described above. When promoting these measures, we gather and analyze traffic data, and run a PDCA cycle with the cooperation from various stakeholders.

But in order to promote international harmonization in the aspects of further advancing safe and environmentally friendly vehicles in the future, it is perceived that approaches made in coordination with the World Forum for the Harmonization of Vehicle Regulation (WP.29) under the UN will become increasingly important.
This report is an internal working document summarising EU road safety statistics reported by the EU Member States for 2015 (2014 when data from 2015 are not available).

For more information, contact the European Commission, Directorate-General Mobility and Transport, Unit C.2 — Road Safety: MOVE-C2-SECRETARIAT@ec.europa.eu

http://ec.europa.eu/roadsafety

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<td>SE</td>
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<tr>
<td>UK</td>
<td>United Kingdom</td>
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</tbody>
</table>
Every day, 70 people die on European roads and 370 suffer serious road traffic injuries. This is tragic and simply unacceptable.

The European Day Without a Road Death (EDWARD) on 21 September 2016 was a great opportunity to encourage all road users to reduce risks and improve safety while driving, riding, walking or cycling. The results were excellent and encouraging. By increasing awareness for just one day, we had a 39% lower fatality rate than the year before, and 27 lives were saved. 19 out of 31 participating countries succeeded in having no deaths, while 7 others recorded significantly reduced fatality numbers on that day. A fantastic achievement for EDWARD this year!

This clearly demonstrates that when all stakeholders come together we really can make an impact and save lives. Together with law enforcement authorities, we will continue to use events like this to make sure that more attention is paid to the problem of road fatalities and serious injuries.

Road safety is one of my top priorities as EU Commissioner for Transport. Our main objective is to save lives and protect people’s health all over Europe.

Road safety in the European Union has improved a lot in recent years: between 2001 and 2015, the number of road deaths decreased by 52%. The EU has the lowest fatality rate of any region in the world: in 2015, the EU reported an average of 51.5 deaths per million inhabitants, against 109 deaths per million in the USA and 174 deaths per million globally.

However, since 2013 progress in the EU has slowed down in this area. The latest road safety statistics for 2015 show that the number of fatalities on our roads has not decreased over the past two years. This trend needs to be taken seriously.

We need fresh ideas, projects and action to successfully move towards our 2020 road safety goals. We should never forget that every death on our roads is simply one too many. Road safety concerns all of us. Project EDWARD has shown that we can deliver incredible results when joining forces. We are on the right track to making the aspirational goal of zero fatalities a reality.

Violeta Bulc
EU Commissioner for Transport
1. The EU’s road safety situation in 2015

- In 2015, 26 112 people died on EU roads.

- There is no improvement compared to 2014 and 2013.

- Between 2010 and 2015, the number of road deaths decreased by 17%. This means 5 400 fewer deaths in 2015 than in 2010.

- The EU’s 2015 road fatality rate was 51.5 deaths per million inhabitants.

- In 2015, the countries with the lowest fatality rate per million inhabitants were Sweden (27), the UK (28), Denmark (31), the Netherlands (31) and Malta (26).

- Countries with the weakest road safety records were Bulgaria (98), Romania (95), Latvia (95), Lithuania (83), and Croatia (82).

- In 2015, seven EU countries recorded a fatality rate below 40 deaths per million inhabitants and none of the Member States had a fatality rate above 100 deaths per million inhabitants.
European roads remain the safest: with 51.5 road fatalities per one million inhabitants, the EU has the lowest fatality rate out of all regions in the world. Between 2001 and 2010, the EU cut the number of road deaths by 43%, and between 2010 and 2015 by another 17%. 26,112 people lost their lives in the EU last year. This is 5,400 fewer than in 2010.

However, progress has clearly slowed down lately: the change in fatality figures was close to zero from 2013 to 2014, and in 2015 there was even a slight increase. This means that efforts must be stepped up, especially at national level, to reach the strategic target of halving the number of road deaths by 2020.

**EU FATALITIES AND TARGETS 2001-2020**

While most Member States have improved their road safety records since 2010, there is still a significant gap in performance across the EU. In 2015, countries with the lowest fatality rate per million inhabitants were Sweden (27), the UK (28), Denmark (31), the Netherlands (31) and Malta (26). On the other hand, those with the weakest road safety records were Bulgaria (98), Romania (95), Latvia (95), Lithuania (83), and Croatia (82), even if two of them reported a significant decrease from 2014 to 2015: Latvia (-11%) and Lithuania (-9%).

In 2015, most EU countries recorded a fatality rate below 80 deaths per million inhabitants and, for the first time ever, seven EU countries recorded a fatality rate below 40 (the EU average was 51.5). In addition, and for the very first time, none of the Member States had a fatality rate above 100 deaths per million inhabitants.
In 2015, on average only about 8% of road fatalities occurred on motorways; 37% happened in urban areas; most (55%) occurred on rural roads.
Vulnerable road users, including pedestrians, cyclists and motorcyclists, accounted for almost half of the road victims, and their proportion was even higher in urban areas. 21% of all people killed on roads in 2015 were pedestrians, and pedestrian fatalities decreased at a lower rate than other fatalities (by 11% from 2010 to 2015, compared to the total fatality decrease of 17%). Cyclists accounted for 8% of all road deaths in the EU. The number of cyclist fatalities decreased by only 4% between 2010 and 2015, which is much lower than the total fatality decrease (17%). Motorcyclists, who are less protected during a crash, accounted for 14% of road fatalities.
For every person killed in traffic crashes, many more suffer serious injuries with life-changing consequences. Serious injuries are not only more common but are also often more costly to society because of the long-term rehabilitation and healthcare needed. Vulnerable road users, such as pedestrians, cyclists, motorcyclists or elderly road users, are especially affected.

As of 2015, Member States started to report data on serious injuries based on a new, commonly agreed definition following medical standards. The international MAIS trauma scale (maximum abbreviated injury score) has been used as the EU definition of serious road traffic injuries since 2014. The ‘scale 3 and more’ (MAIS3+) is the one that applies to serious injuries.

Until now, the Commission has received preliminary data from sixteen Member States (Belgium, the Czech Republic, Germany, Spain, Ireland, France, Italy, Cyprus, the Netherlands, Austria, Poland, Portugal, Slovenia, Finland, Sweden and the United Kingdom). The quality of these data is currently being checked. Further data are expected from at least Romania and Estonia. The countries for which data is available represent about 80% of the EU’s population and account for 80% of all fatalities.

Based on the data provided, it is estimated that 135,000 people are seriously injured on EU roads. Therefore, on average there are 5 serious injuries for each road fatality in the EU. Most of those seriously injured are vulnerable road users, such as pedestrians, cyclists and motorcyclists, and most are elderly, an age group that is growing in number. Their proportion is even higher in towns and cities.
## NUMBER OF SERIOUSLY INJURED IN EU MEMBER STATES

<table>
<thead>
<tr>
<th>MEMBER STATE</th>
<th>FATALITIES BY POPULATION</th>
<th>HOSPITALISED</th>
<th>SERIOUSLY INJURED MAIS3+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belgium</td>
<td>65</td>
<td>373</td>
<td>265</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>98</td>
<td>320</td>
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<tr>
<td>Czech Republic</td>
<td>70</td>
<td>236</td>
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<td>315</td>
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<tr>
<td>Germany</td>
<td>43</td>
<td>834</td>
<td>190</td>
</tr>
<tr>
<td>Estonia</td>
<td>51</td>
<td>352</td>
<td>n.a</td>
</tr>
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<td>36</td>
<td>98</td>
<td>74</td>
</tr>
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<td>Greece</td>
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<td>99</td>
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<td>Spain</td>
<td>36</td>
<td>204</td>
<td>137</td>
</tr>
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<td>France</td>
<td>54</td>
<td>412</td>
<td>388</td>
</tr>
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<td>82</td>
<td>668</td>
<td>n.a</td>
</tr>
<tr>
<td>Italy</td>
<td>56</td>
<td>790</td>
<td>246</td>
</tr>
<tr>
<td>Cyprus</td>
<td>67</td>
<td>445</td>
<td>98</td>
</tr>
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<td>Latvia</td>
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<td>n.a</td>
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<tr>
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<td>83</td>
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<td>561</td>
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<tr>
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<td>n.a</td>
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<td>26</td>
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<td>n.a</td>
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<td>444</td>
</tr>
<tr>
<td>Austria</td>
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</tr>
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<td>Poland</td>
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<td>456</td>
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<td>Finland</td>
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<td>United Kingdom</td>
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<td>78</td>
</tr>
<tr>
<td>EU</td>
<td>51.5</td>
<td>485</td>
<td>257</td>
</tr>
</tbody>
</table>
A recent study\(^1\) carried out with the support of the European Commission analyses the most common characteristics of road traffic crashes that cause injuries of a MAIS3+ severity. The study provides an understanding of the most common factors contributing to serious road traffic injuries for pedestrians, bicyclists, motorcyclists and car occupants in the EU.

**Common characteristics of crashes that severely injure pedestrians:**
- Men and women are about equally represented.
- Elderly people and children are most at risk.
- Mainly cars and heavy vehicles are involved.
- Crashes occur mostly in urban areas on 50 km/h road sections.
- Main contributing factors are failure to look before crossing, poor judgment, speed and psychoactive substances.
- Head- and upper body injuries are most common when heavy vehicles and higher speed roads are involved. Legs are often injured in crashes involving cars on lower speed roads.

**Common characteristics of crashes that severely injure cyclists:**
- Men are overrepresented.
- Mostly the elderly, young people and children are at risk.
- Crashes involve cars or occur in single vehicle crashes.
- Crashes occur mainly in urban areas on 50 km/h road sections or intersections.
- Main contributing factors are failure to look, poor judgment, reckless driving and loss of control.
- Head injuries are frequent in all crash scenarios. Legs are mainly injured in single vehicle crashes involving elderly people on lower speed roads. Thorax injuries mainly happen in side-impact crashes in urban areas and at junctions.

\(^1\)Study on Serious Road Traffic Injuries in the EU (SUSTAIN) http://ec.europa.eu/transport/road_safety/topics/serious_injuries_en
Common characteristics of crashes that severely injure motorcyclists:

■ More than 90% of victims are men.
■ Young people and middle-aged are most at risk.
■ Crashes mainly involve cars or fixed objects, or happen without an opponent.
■ Most crashes happen in rural areas or on urban roads.
■ Main contributing factors are failure to look, poor judgment, speeding and loss of control.
■ Thorax injuries happen mostly in single vehicle crashes involving fixed objects on rural roads. Leg injuries occur mostly in crashes involving cars.

Common characteristics of crashes that severely injure car occupants:

■ Two thirds of victims are men.
■ Young people are most at risk.
■ Most crashes involve cars or fixed objects, or occur without an opponent.
■ Most injuries occur on rural roads, when driving at speeds of over 70 km/h.
■ Main contributing factors are loss of control, speeding and the use of psychoactive substances.
■ Thorax injuries are most common in crashes involving two cars, when car occupants wear seat belts but there is no airbag. Head injuries occur most frequently when a car crashes into a fixed object or heavy vehicle, when the driver is not wearing a seat belt and there is no airbag. Leg injuries occur most often in car-to-car crashes in lower speed zones.
2. Young people (18-24)

- Young people (between 18 and 24 year old) account for 14% of those killed on roads but represent only 8% of the population.

- Young people are almost twice as likely to be killed in a road crash than the average person.

- The number of young people died on the roads decreased by 65% between 2001 and 2015, more than for any other age group.

- In 2015, two thirds of young people killed in road crashes in the EU were drivers, whereas only 8% were pedestrians.
In 2015, more than 3,500 young people – those between 18 and 24 years – died in road crashes in the EU. Young people are far more likely to be victims of road crashes than any other age group. In 2015, almost 14% of people killed on EU roads were aged between 18 and 24. However, only 8% of the population falls within this age group.

The number of young people killed in road crashes more than halved between 2001 and 2015, while the total number of road deaths in the EU also fell by 52% over the same period.
The distribution of fatalities by age group has changed in recent years. On the one hand, the EU significantly reduced fatalities among young people over the last 25 years. On the other hand, the proportion of elderly people killed in road crashes has strongly increased. This trend goes hand-in-hand with how the population’s age structure is changing: fewer younger and middle-aged people and more elderly people.

Men are still largely overrepresented among young victims: 80% of young people killed in road crashes were men. This can be explained by young men's different risk-taking behaviour and also by the fact that young men tend to take longer trips than young women do.

Most young people killed in road crashes were drivers (67%), while only 8% were pedestrians.

The majority (61%) of young people were killed in road crashes outside urban areas, on rural and interurban roads, and only 6% of fatalities occurred on motorways. Young people fatalities in built-up areas accounted for 32% in the EU.

**ROAD FATALITIES BY ROAD USER TYPE**

![Diagram showing road fatalities by road user type for all ages and young people aged 18-24.](image-url)
In all EU countries, elderly people are at greater risk of being killed in a road crash than the overall population.

Elderly people accounted for 18% of road fatalities in 2010 and 26% in 2015.

Most elderly road victims are pedestrians (37%) and most pedestrian fatalities occur in urban areas.

Across the EU, the fatality rate for elderly men is twice as high as the rate for elderly women.
In an aging society, the role of elderly people (65+) in road traffic requires closer attention. The proportion of elderly people in the total population is increasing and the proportion of elderly people among road traffic victims is also increasing.

Although older drivers are involved in fewer road crashes, elderly people in general are one of the highest risk groups. They are more vulnerable because they are more fragile, with often reduced eyesight and reaction speed.

### NUMBER OF ELDERLY FATALITIES AND ALL ROAD FATALITIES IN THE EU

![Graph showing number of elderly fatalities and all road fatalities in the EU from 2010 to 2015]

Even if the number of elderly road victims has decreased over time, the total number of road deaths has fallen faster, thus the proportion of elderly fatalities rose. While 18% of road fatalities involved elderly people in 2010, this ratio reached 26% in 2015.

Compared to the average population, the risk of being killed on roads is almost one and half times higher for an elderly road user. In general, the average age of road victims is on the rise in the EU.
ELDERLY FACE HIGHER RISKS IN URBAN AREA

Outside urban areas

- 80% Others
- 20% 65+

Urban areas

- 64% Others
- 36% 65+

There are fewer elderly fatalities on motorways and on rural roads, but more on urban roads. This is probably a result of the fact that most elderly road victims are pedestrians and most pedestrian fatalities occur in urban areas.

In general, people aged 65 and over are especially over-represented among pedestrians who are killed in the EU. However, there are significant differences between the Member States.

The high proportion of elderly people killed in road crashes as pedestrians also reflects their reduced mobility options.

Men are overrepresented among elderly road victims: almost two thirds of elderly people killed in a road crash were men. At the same time, women make up a higher proportion of fatalities among the elderly (36%) than within the population in general (24%).
4. Gender

- Since 2001, fatality rates decreased for both men and women in all EU countries.
- Far more men than women are killed in road crashes: only 24% of fatalities are women, while 76% are men.
- The proportion of male drivers killed exceeds 80% in some countries.
- Women are over-represented as passengers and pedestrians among road victims.
In 2015, about 26 100 people were killed in road crashes throughout the EU, which means 5 400 fewer than in 2010. There is no difference between genders in this positive development in the EU overall: the number of road fatalities decreased by 17 % for both men and women. There are, however, many gender-related differences in individual countries.

**DISTRIBUTION OF ROAD FATALITIES BY GENDER IN THE EU**

![Gender Distribution Chart]

In general, far more men than women are killed in road crashes: fewer than a quarter of all fatalities are women, and 76 % of fatalities are men.

Men are still overrepresented among young victims: 80 % of young people who died in road crashes were men. At the same time, the fatality rate of elderly men is over twice the rate of elderly women in most EU countries.

The ratio between male and female road victims increases with age and reaches the peak for men between the ages of 30 to 34. It then falls among older age groups. More than 80 % of road fatalities aged 20 to 54 were men, and overall 76 % of road victims were male. This reflects a specific gender development in the travel behaviour of men and women in Europe.
Male and female road fatality figures also differ across road user categories. In 2015, more women than men were killed in passenger cars, but far more men than women were killed while riding motorcycles. Among pedestrians, almost twice as many women were killed as men.

Among drivers, the proportion of fatalities is higher for men than for women. The proportion of men exceeds 80% in some countries. Women are overrepresented among passenger and pedestrian fatalities in all countries.
Conclusions

The EU has an ambitious road safety target for this decade: halving the number of road deaths between 2010 and 2020. The target is very challenging to reach but we should not give up trying. In order to make up for the stagnation in 2013-2015, fresh efforts are needed from all involved, from policy-makers to road users.

The latest road safety trends clearly show the areas in which work should be concentrated. Although the rate of road fatalities among young people has decreased over the last decade, this is not true for elderly road users. Therefore, elderly people, especially pedestrians, deserve additional attention as part of urban road safety efforts. In an aging society, it is our common responsibility to make roads safe for elderly people to use.

There are many gender-based differences in road safety trends. This reflects a specific gender development in the travel behaviour of men and women in Europe. The differences show that road users’ behaviour plays a crucial part in safety, and this should be taken into account when designing new policies or raising awareness about risks on the road.

Future work includes new possibilities for analysing the non-fatal but still serious road crashes. In 2015, Member States reported the first EU-wide data on serious road injuries. Understanding the real scope of the injury problem is the first step to reducing the number of road crashes that result in serious injuries.
For more information about the European Commission and road safety, visit our website:

http://ec.europa.eu/roadsafety
FATALITIES IN ROAD TRAFFIC ACCIDENTS

Analysis of road traffic accidents statistics

The efforts led by the Government of the Republic of Korea to reduce the fatalities and road traffic accidents played a major role in decreasing the fatality rate in road traffic accidents. In the past 5 years (2012-2016) the fatalities from road traffic accidents continued to decrease due to the implementation of the 7th transportation safety master plan. Table 1 and Figure 1 show that the number of fatalities from road traffic accidents was decreased by 17.9 % from 5,229 deaths in 2011 to 4,294 deaths in 2016. Even though the fatality rate was decreased below 10 deaths in 100,000 populations since 2014, the rate is still twice as high as those of countries with good road traffic safety records. The number of vehicle registered has increased from 18.44 million in 2011 to 20.99 million with an annual rate 3.3 %. On the other hand the fatalities have decreased with an annual rate of 3.9 %.

Table 1.  
Total fatalities and fatalities per 100,000 (unit: death)

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</thead>
<tbody>
<tr>
<td>Total Fatalities</td>
<td>5,229</td>
<td>5,392</td>
<td>5,092</td>
<td>4,762</td>
<td>4,621</td>
<td>4,294</td>
</tr>
<tr>
<td>Fatalities per 100,000</td>
<td>10.5</td>
<td>10.8</td>
<td>10.1</td>
<td>9.4</td>
<td>9.1</td>
<td>8.5</td>
</tr>
</tbody>
</table>

Figure 1. Road traffic fatalities
To improve national road safety the 8th transportation safety master plan was established and will be implemented in the next 5 years (2017-2021). The goal is to decrease the number of fatalities of road traffic accidents to be below 2,800 by 2021. To reduce the pedestrian fatalities which accounts for 38% of the total fatalities, the road traffic environment will be improved to pedestrian-friendly environment and the pedestrian protection regulations will be strictly enforced. In addition, various measures will be carried out to cope with the increase in accidents associated with older drivers; the period to renew drivers' licenses of the advanced age will be adjusted; the management of older drivers with geriatric illness will be revised; the aptitude tests for older commercial drivers will be strengthened.

The major tasks in the road safety of the 8th transportation safety master plan are as follows;
A. Road uses: the reduction of pedestrian fatalities by 40 %; the strengthening of safety management of older drivers such as the implementation of preventive measures tailored for older drivers-involved traffic accidents and the improvement of older drivers' driving performance
B. Road environments: the reduction of accident severity by speed enforcement; the intensive management of risks in the roads prone to accidents
C. Advanced Vehicle Safety: Active prevention of traffic accidents with the application of advanced vehicle safety features; Rapid response to the future transportation environment such as autonomous vehicles
D. Safety management system: the strengthening of safety management of commercial vehicles; the improvement in the legal system for the strengthening of transportation safety; the strengthening of roles and responsibilities of local governments enforcing road safety

The 2nd vehicle policy master plan
In 2016 the 2nd vehicle policy master plan was established due to the necessity of strategy reestablishment to reflect the changes in vehicle policy and technologies since the 1st vehicle policy master plan (2011-2016). To improve vehicle safety and to protect people from traffic accidents, the implementation direction of vehicle safety and management policy was proposed to cope with the change in vehicle policy environments and new technologies in the next 5 years (2017-2021). The plan has several purposes, for example the directives of vehicle research and development for improving safety and the international harmonization policy of vehicle technical regulations to timely reflect international regulations to domestic regulations. In addition the strategy and detailed tasks were prepared to secure international competitiveness and to provide convenient and reliable vehicle service to people.

The major tasks in the 2nd vehicle policy master plan are following;
A. The strengthening of vehicle safety and international cooperation: reorganize the vehicle safety regulation system; strengthen vehicle safety; assist the promotion and sales of advanced vehicle safety features; new periodic inspection of in-use vehicles with advanced vehicle safety features; strengthen international vehicle regulation harmonization and international cooperation
B. The improvement of vehicle service platform for vehicles lifetime: improve the vehicle license plate in quantity and quality; create the reasonable vehicle maintenance service culture; enlarge the vehicle aftermarket such and tuning and replacement parts; establish the transparent system of used vehicle trade; Revitalize the recycle and reuse industry of end-of-life vehicles
C. The strengthening of consumers' rights: improve the vehicle recall system and quality control system; improve the mutual aid business system; rationalize the liability insurance system; strengthen the aid to traffic accident victims
D. The establishment of vehicle operational environment for future vehicles: assist the deployment of autonomous vehicles; create the environments for eco-friendly vehicles; provide the future mobility service; create the transport network based on vehicles
E. The establishment of a sustainable vehicle policy making system: establish the system to utilize big data based on vehicle statistics; improve the vehicle regulatory system; foster vehicle experts for the era of future vehicles

INTERNATIONAL HARMONIZATION ACTIVITIES

The Republic of Korea, a contracting party to 1958 Agreement and 1998 Agreement, have been harmonizing domestic vehicle safety regulations with UN Regulations and UN Global Technical Regulations (GTR) under
UN/ECE/WP.29. This section introduces what Korean Government is carrying out regarding international harmonization.

**Research on international harmonization**

The harmonization of domestic vehicle safety regulations has been carried out according to the annual plan of Table 2. In 2015 researches on brake lining, wheels of passenger vehicles, installation of lighting equipment of motorcycles, electromagnetic compatibility have been completed. In 2016 researches on eight subjects, such as camera monitor system, brake lining, seatbelt reminder, have been completed. In 2016 eight regulations have been studied, and 75 subjects will be completed among the target of 85 subjects by the end of 2017.

<table>
<thead>
<tr>
<th>Year</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017 (planned)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harmonization Rate (%)</td>
<td>65.9</td>
<td>71.8</td>
<td>78.8</td>
<td>88.2</td>
<td>95.3</td>
</tr>
<tr>
<td>Number of Research Subjects (cumulative)</td>
<td>4 (56)</td>
<td>5 (61)</td>
<td>6 (67)</td>
<td>8 (75)</td>
<td>4 (81)</td>
</tr>
</tbody>
</table>

In recent two years the following domestic vehicle safety regulations are harmonized with UN Regulations and UN GTR.

2015: UN GTR11 (Engine emissions for non-road machinery)
2016: UN R18 (Protection against unauthorized use), UN R27 (Advance warning triangles), UN R36 (Construction of public service vehicles (space for fire extinguisher)), UN R66 (Strength of the superstructure if large passenger vehicles), UN R69 (Rear marking plates for slow moving vehicles), UN R75 (Pneumatic tyres (moped, motorcycle)), UN R81 (Rear-view mirrors (motorcycle)), UN R90 (Replacement brake lining assemblies), UN R121 (Identification of controls & tell-tales), UN R124 (Passenger car wheel), UN R130 (Lane departure warning system), UN R131 (Advanced emergency braking system)

**Seatbelt reminder**

In the existing UN R16 and domestic vehicle safety regulation, the seatbelt reminder was mandatory for front row seats. The seatbelt wearing rate in the second or rearward row seats was as low as 16.2 % in 2013. This minimal (or dismal) rate made the seatbelt reminder mandatory for all seats to increase the seatbelt wearing rate. The Republic of Korea proposed the mandatory installation of seatbelt reminder for all seats of passenger vehicles at the WP.29/GRSP in December, 2014. Afterward the Republic of Korea submitted an amendment proposal in collaboration of European Union, France and Japan. The 169th session of the World Forum approved the amendment in November, 2016. It will be effective from September 2019 in Korea in the hope that the safety of all passengers will be improved drastically.

**Amendment proposal of fire resistance of rechargeable electric energy storage system (REESS)**

As electric vehicles are widely accepted in the world vehicle market, it became necessary to strengthen the safety of rechargeable electric energy storage system in an electric vehicle. In 2012 the Republic of Korea proposed a new test method of fire resistance for REESS at the GTR electric vehicle safety informal working group. From 2013 to 2016 ROK conducted various comparative studies between a proposal and the existing test procedures. The study results showed that the repeatability, reproducibility and reliability of a proposal have been improved. The new test procedure was adopted as an alternative to the existing regulation in March, 2016.

**Participation in developing safety regulations of autonomous vehicles**

The World Forum for Harmonization of Vehicle Regulations (WP.29) established the automatically commanded steering function informal working group in 2015 to develop safety regulations regarding autonomous vehicles. Korea proposed an amendment to existing domestic regulations for autonomous vehicles and wished to share the study results with international partners. The amendment proposals were mainly focused on the maximum speed, advanced driver assistance system.
Amendment to pedestrian protection for active hood

The pedestrian fatalities, a leading fatality, account for 38% in Korea. It needs a serious countermeasure to deal with the reduction of pedestrian fatalities. In recent years vehicles with an active hood system have been introduced in the market. However, the existing UN R127 and UN GTR9 hinder the introduction of an active hood because those regulations lack the test procedures for active hood systems. In 2015 Korea proposed to amend the existing regulations in agreement with international partners and International Organization of Motor Vehicle Manufacturers (OICA). The study was carried to clarify the conditions of an analysis model for head impact duration and to develop a test method for active hood systems in 2016. Korea became a leading contracting party for amending the existing regulations in 2016. This group actively is working on developing a new test procedure for active hood systems.

AMENDMENTS OF DOMESTIC VEHICLE SAFETY REGULATIONS

Advanced driver assistance systems in heavy-duty commercial vehicles

Mandatory installation of advanced driver assistance systems in heavy-duty commercial vehicles has been studied under the project, 'Development of safety assessment of advanced driver assistance systems' since 2012, because advanced driver assistance systems were proven to be effective to prevent the traffic accidents of heavy-duty commercial vehicles. In 2015 the amendments to existing vehicle safety regulations were proposed for lane departure warning system, automatic emergency braking system. The mandatory installation of advanced driver assistance systems are in progress of legislation.

In 2016 a tragic accident in a tunnel happened in a tunnel, with 4 death and 38 injured. This accident prompted rapid legislation and counter measures. The effectiveness analysis and legislation of advanced driver assistance systems were prepared in 2016. Mandatory installation of advanced driver assistance systems in heavy-duty commercial vehicles was promulgated and effective in January 2017 for new model vehicles, and will be effective for current model buses in 2018 and current model trucks in 2019.

Emergency exit in case of fire, immersion and other situation

In 2016 the door of a chartered bus caught fire and stuck at an accident on the express way. This accident resulted in 10 deaths. The existing regulation on the emergency exit in the bus requires one or more emergency exit. The windows are an alternative to the emergency exit. However, this requirement is not adequate and poses a high risk in fire or under water. In 2016 the amendment was promulgated to require one or more emergency exit (at least one emergency exit for buses with 30 or less passengers, more than one emergency exit for buses with 31 or more passengers) and emergency escape devices from 3 to 11 according to the number of passengers in January, 2017 to strengthen the safety of bus passengers. This requirement will be effective for new buses with 16 or more passengers in 2019.

Figure 2. Escape simulation through emergency exits of large bus
Camera monitor system

The UN R46 on rear view mirrors was amended to introduce a camera monitor system as an alternative to rear view mirrors in November, 2015. The domestic vehicle safety regulation on rear view mirrors was harmonized to accept a camera monitor system in January, 2017. This amendment enabled vehicle manufacturers to develop and apply advanced safety systems to improve vehicle safety by amending current vehicle safety regulations impeding new vehicle safety features and innovative vehicle design.

NEW CAR ASSESSMENT PROGRAM

There are many changes in the assessed items and contents of the new car assessment program in 2017. The assessment of pedestrian protection is strengthened and more advanced driver assistance systems will be assessed. The point system to each assessed field is modified also. Sixty points are allocated to crashworthiness, 25 to pedestrian protection, 15 to active safety systems (additional merit of 2 points). The points allocated to crashworthiness was reduced by 5 points, on the other hand the points to active safety systems were increased by 5 points.

Strengthening the assessment for vulnerable road users

Traffic accidents involved with children account for 5.4 %, and those involved with female drivers account for 40.6 %. However the current new car assessment program is focused on the protection of male drivers based on the physical characteristics of an average male driver. In the past two years (2014-2015) the study on protection of vulnerable road users, such as children and small female drivers was carried to justify (support) the grounds for protection tailored to children and small female drivers. Dummies of 6 and 10 years old will be boarded in the events of off-set frontal collision test, side impact test and chest compression will be measured. Due to the increase of female drivers the assessment procedure was developed for female drivers based on the physical characteristics of female drivers, apart from the male-oriented assessment procedures.

Assessment of advance driver assistance systems (ADAS)

The efforts Advance driver assistance systems are effective for preventing accidents so that the plan for the assessment procedures of advance driver assistance systems was established as a mid-to-long term project of the development of new assessment procedures. Since 2014 a lane departure warning system, forward collision warning system, and a seatbelt reminder have been assessed. From 2017 thirteen ADAS will be assessed, including a lane keeping assistance system, an automatic emergency brake system, an intelligent speed assistance, a blind spot detection system and a rear cross traffic alert system.

Study on the new car assessment program

The following fields in the new car assessment program will be studied to continuously improve the program in 2017.
- Establish the mid-to-long term plan to improve the program
- Develop assessment procedure of AEBS for pedestrian during the night
- Develop assessment procedure of lighting equipment for night visibility
- Baseline study for developing assessment procedure of vehicle-to-vehicle crash
- Develop assessment procedure of female passengers in the 2nd row seats in a passenger vehicle
- Analysis of crashworthiness effectiveness

RESEARCH AND DEVELOPMENT

Establishment of the 2nd vehicle policy master plan

The 1st vehicle policy master plan (2011-2016) was established and implemented. The 2nd vehicle policy master plan was established in 2016, taken into consideration of the changes in vehicle environments and technologies. The
Ministry of Land, Infrastructure and Transport (MOLIT) established the road map of the National Vehicle Policy. In the road map 5 main strategic projects and 18 detailed tasks were developed. Those projects will be implemented for the next 5 years, including five main strategies such as, "A leading role in international harmonization", "Create a vehicle operational environment for future advanced safety vehicles".

Through these projects MOLIT will lay a firm ground for a mid-to-long term policies, research and development projects, an international harmonization center, wide application of advanced driver assistance system, and expansion of transportation safety business with Korea Transportation Safety Authority / Korea Automobile Testing & Research Institute (TS/KATRI). In addition the MOLIT will strengthen the research and development of future vehicles and the cooperation network for the commercialization of autonomous vehicles to promote the research and development of future vehicle safety, including autonomous vehicles and environment-friendly vehicles. Also the MOLIT will lay a foundation for the system to respond to the new climate regime, and strongly support a infrastructure system reformation for environment-friendly vehicles.

**Safety of micro mobility (L7 category)**

Recently single passenger personal mobility as environment-friendly and short-distance transporter became available to the public. The current vehicle classification system, which lacks safety requirements and vehicle category, poses an impediment to the introduction of micro mobility. To resolve this issue the study on micro mobility is being carried out from December of 2015 to June of 2017. The main research subjects are classification, safety regulations, cost/benefit analysis and assessment of 4 fields (general safety, active safety, passive safety and performance). In the proposal micro mobility will be classified in the micro mobility to be included in the current category of light vehicles. For the safety requirement proposal, 29 current safety standards will be applied and 23 new safety standards only for micro mobility will be introduced. In the near future crashworthiness of micro mobility including frontal collision test, will be reviewed.

**Approval of real world test of autonomous vehicle and public access to the ITS proving ground**

To lift the regulatory barrier to development of autonomous vehicles a temporary approval of real world road test for autonomous vehicles was introduced in February 2016. Seventeen approvals were granted up to March 2017. The approval system helps the vehicle manufacturers to expedite development of autonomous vehicle technology by accumulating '26,000 km without accidents in the real world' and verifies the safe operation of autonomous vehicles in the real world. ITS proving ground is accessible by universities with limited resources. From 2015 TS/KATRI lowered its fees of proving ground by 50% for universities. From 2016 universities are able to use proving ground free of charge in the weekend. In addition TS/KATRI offers state-of-art proving ground, such as, DGPS, traffic signal system to universities at no cost. These efforts by TS/KATRI help universities to develop autonomous vehicle technology and to train experts for the future.

* Intelligent Transport Systems proving ground: 364,000 square meters

**Expansion of research and development**

The assessment procedures of core technologies in autonomous vehicles have been developed under the project of 'Development of assessment procedures for advanced safety vehicles (2015-2017)' since 2009 (Table 3). The test bed is under construction to assess three core safety fields of autonomous vehicles. The test bed (K-city) infrastructures is under construction and the assessment procedure of autonomous vehicle safety is being developed under the Government' policy of 'Early commercialization of autonomous vehicles by 2020'.

**Research on autonomous vehicles** The planning research was carried out for "Development of assessment procedures of autonomous vehicle safety and construction of test bed" from August 2105 to May 2016. Core safety fields, such as operation, failures and internal communication security, of autonomous vehicles are being studied from June 2016 to December 2018. The planning research was carried out for "Development of assessment procedures of driver's taking back control of autonomous vehicle and Improvement of social receptivity of autonomous vehicle" (August 2015-May 2016). The main research is under way from April 2017 to December 2020.
Table 3.
Road map of assessment procedures for advanced safety vehicles research

<table>
<thead>
<tr>
<th>Year</th>
<th>2009</th>
<th>1st Phase</th>
<th>2012</th>
<th>2nd Phase</th>
<th>2015</th>
<th>3rd Phase</th>
<th>2017</th>
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<td>Passive Safety</td>
<td>protection of rear seat passengers</td>
<td>protection of far side passenger</td>
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<td>active headrest</td>
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<td>pole-side impact</td>
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<td>Active Safety</td>
<td>Passenger vehicle ACC/commercial vehicle AEBS</td>
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<td>lane departure warning system</td>
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<td>blind spot detection</td>
<td>ESC of commercial vehicle</td>
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<td>AFLS</td>
<td>safety assessment of active safety vehicles</td>
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<td></td>
<td>crashworthiness of active safety vehicles</td>
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<td>Social Infrastructure</td>
<td>e-call</td>
<td>Injury DB (1st phase)</td>
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<td>cost/benefit analysis of ADAS</td>
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<td>power of electric vehicle</td>
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Construction of test bed (K-city) for autonomous vehicle In the TS/KATRI proving ground (364,000 square meters) a experimental city integrated with communication system is being constructed for testing autonomous vehicles. The world-class experimental city suitable for testing autonomous vehicles is under construction to secure the assessment procedures of three core safety fields, such as operation and failures, cyber security and driver's taking back control, of autonomous vehicles. By October 2017 a motorway system dedicated for vehicles will be completed. By December 2018 the rest of roads (downtown, rural roads and community roads) will be completed.

Figure 3. Test bed (K-City) for autonomous vehicles
**Improvement of commercial vehicle safety** Various measures of management of commercial drivers and transport companies have been implemented to improve commercial vehicle safety. In December 2012 a digital tacho graph became mandatory in heavy-duty commercial vehicles. The data from digital tacho graphs will be utilized for improving safety. A lane departure warning system and an automatic emergency braking system became mandatory in buses longer than 11 meters and heavy-duty trucks with 20 or more tons GVW in January, 2017. The Ministry provides subsidy owners of heavy-duty commercial vehicles for retrofitting LDWS and FCWS since September 2016. This subsidy will be increased to have more vehicles equipped with advanced driver assistance systems.

**CONCLUSION**

The Korean Government keep pace with the development of new safety technology in the future transport environment to reduce traffic accident fatalities through preventive measures and autonomous vehicles like application of advanced driver assistance systems as a main task of vehicle safety improvement. The legislation system of vehicle safety regulations will be revised to improve transparency and predictability. The ministry will strongly support international harmonization activities and make advanced driver assistance systems available as much as possible. International cooperation will be strengthened. Furthermore the Ministry will take every effort to create the operational environment amicable for future advanced safety vehicles.

**REFERENCES**

1. STATUS AND TRENDS

1.1. Road accidents in Germany

The total number of police registered road accidents has stagnated for the last 10 years – between 2.2 and 2.5 million road accidents. There were slight increases in single years such as 2007, 2010 or 2015, but as well slight decreases in 2002 or 2011. On the long run, there is an increase since 2000 by 7 % in 2015. The forecast for 2016 also indicates an increase in accident figures by roundabout 3 % (2015: 2.52 million road accidents).

The number of road accidents with personal injury has decreased by 20 % since 2000, resulting in 305,659 road accidents with personal injury in 2015. This number has increased in the last two years by about 5 % and for 2016 again a slight increase of almost 0.3 % to approximately 306,500 injury accidents is expected.

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 more than 22 % from 511,577 in 2000 to 396,891 in 2015. The increased number of injury accidents in the last two years led also to an increased number of casualties of approximately 5 % compared to 2013. In 2016 an increase to about 398,000 casualties is expected.

In contrast to the positive development on the long term, the year 2015 showed an increase of the number of fatalities the second year in a row. And also for the number of injury crashes and casualties the year 2015 was the second year with an increase of accident figures.

The forecast for 2016 shows a stagnating or even increasing number of accidents but a decrease in fatality figures by about 6 %. 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 years 2014 and 2015 were characterized by an early and mild spring, resulting in high accident and fatality figures concerning mainly motorized and non-motorized two-wheelers. The decrease in 2016 is accordingly mainly due to reductions of the fatality numbers for two-wheelers.

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

The Federal Highway Research Institute (BAST) calculates the costs of road accidents on an annual basis. The costs of road traffic accidents to Germany’s national economy include personal injuries and damage to goods. The calculated costs include direct costs (e.g. for medical treatment, vehicle repair/replacement), indirect costs (for police services, the legal system, insurance administration, replacement of employees), lost potential growth (including the shadow economy), lost added value of housework and voluntary work, humanitarian costs, costs of monetised travel time losses due to accidents on motorways. Using the developed calculation model an analysis of very severe injuries and the effect of underreporting on total accident costs could be accomplished.

The calculated total accident costs for 2015 amounted to approximately 34.44 billion Euro. Furthermore, personal injuries amounted to 14.31 billion Euro. Costs of about 20.12 billion Euro were caused by damage to goods.

The costs per person add up to 1.192 million Euro for a fatality, 123,510 Euro for a severely injured person and 5,139 Euro for a slightly injured person.
German Road Safety Programme

The 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.

For the first time, a quantitative target of -40% for fatalities by the year 2020 was set. The target was defined on the basis of scientific research regarding the expected development of road safety until the year 2020 (R. Maier et al., 2012 a). The monitoring and assessment of road safety measures and the development towards the target is done by the Road Accident Prevention Report, which is prepared every two years and submitted to the German Bundestag. In 2015, a Midterm Report has been launched and published, taking stock of the first half of the road safety program. After the increase of fatality numbers in 2014 and 2015 the number of fatally injured traffic participants has been reduced only by 13.7 % since 2011. To achieve the reduction of 40 % by 2020 further efforts in the next years are necessary. As key issues the accidents of pedestrians and cyclists inside urban areas as well as accidents of cars and motorcycles on rural roads were identified.

Figure 1: Costs due to road traffic accidents in 2015 (billion Euro)
2. RESEARCH

2.1. Finished projects

2.1.1. EU Twinning Project - Support to the Ministry of Infrastructure of Ukraine in Strengthening of Safety Standards of Commercial Road Transport

While the accident and mortality rates in the EU tend to decrease, road safety performance in Ukraine remains very low by international standards. The mortality rates from road traffic injuries are among the highest in Europe, standing at 21.5 deaths per 100,000 populations compared to 13.5 averages in WHO European Region.

To help the Ministry of Infrastructure of Ukraine (MoI) in improving the situation, the EU - in consultation with the MoI - considered "institutional twinning" with a Member State (MS) of the EU as the most relevant way to provide assistance in the framework of the EU-Ukraine cooperation. It should accelerate the capacity building of the MoI in benefitting from EU experience and practices, specifically relating to road traffic safety management systems, qualification of directors and managers of road transport companies and drivers, certification of vehicles and their components and accident investigation.

In cooperation with Polish and Lithuanian partners, the German Federal Office for Goods Transport (BAG) and the German Federal Highway Research Institute (BASt) have been involved in the twinning.

BASt took the lead in Twinning Component D, supporting the implementation of technical investigations of accidents. This included assistance in establishing a legal framework, technical education of Ukrainian experts and the preparation of detailed procedures.

It must be noted, that the new draft Law of Ukraine “On Road Transport” includes article 75, according to which road traffic accidents involving vehicles of road operators – physical or legal entities engaged in transport of passengers and goods - are subject to technical investigation. Technical investigations shall be carried out without interference in the work of bodies, the procedural investigation activities of which are foreseen in the legislation.

In particular BASt experts have been conducting analysis of existing legislation and already developed draft legislation in Ukraine in the field of investigation of accidents resulting in heavy consequences. BASt have been providing recommendations on duties and responsibilities of the Ministry of Infrastructure and other stakeholders during the technical investigation. Best EU/international practice has been introduced by means of a stakeholder workshop. BASt has been elaborating detailed procedures for the technical investigations and conducted training workshops for Ukrainian experts from the MoI. To the end a study tour to Germany has been organized, demonstrating also the GIDAS investigation to the Ukrainian partners.

Figure 2: Workshop on the implementation of technical accident investigations in Ukraine, Kiev
2.1.2. **Study on winter tyres**

Winter tyre use for passenger cars is mandatory in Germany if there is snow or ice on the road. Commercial vehicles are required to have tyres with winter characteristics only fitted to their driven axles, and no specific limits for tyre wear and age are set for any vehicles' winter tyres.

Since wear and age of tyres might have a considerable effect on their friction coefficients, BASt has been asked to perform an extensive study on winterly road surfaces to identify reasonable limits. In general, passenger car tyre properties decrease substantially with profile depths below 4 mm, but not with age. This effect had not been found with commercial vehicle tyres.

It seems that a situational requirement to fit belt chains to driven axles could improve the climbing ability of commercial vehicles in specific situations. Since a large amount of traffic jams on German highways in winterly conditions is due to trucks being stuck, this could in fact improve winterly traffic flow.

2.1.3. **Study on Camera-Monitor-Systems**

Within the automotive context camera monitor systems (CMS) can be used to present views of the traffic situation behind the vehicle to the driver via a monitor mounted inside the cabin. This offers the opportunity to replace classical outside and inside rear-view mirrors and therefore to implement new design concepts, aerodynamically optimized vehicle shapes and to reduce the width of the vehicle. Further, the use of a CMS offers the potential to implement functionalities like warnings or situation-adaptive fields of view that are not feasible with conventional rear-view mirrors. Despite these potential advantages, it is important to consider the possible technical constraints of this technology and its effect on driver perception and behavior. On the technical side and besides the field of view and the robustness of the system, aspects like functionality at day and night as well as under varying weather conditions have been object to a scientific investigation conducted by BASt. Concerning human machine interaction the perception of velocities and distances of approaching vehicles have been considered as they might be different for CMS as compared to conventional rear-view mirrors. Potential influencing factors like the position of the display or drivers’ age have been taken into account. Within the BASt study CMS have been tested under controlled conditions as well as in real traffic for passenger cars and heavy goods vehicles.

In general, it was shown that it is possible to display the indirect rear view sufficiently for the driver, both for cars and trucks, using CMS which meet specific quality criteria. Depending on the design, it is even possible to receive more information about the rear space from a CMS than with mirror systems. It was also shown that the change from mirrors to CMS requires a certain period of familiarization. However, this period is relatively short and does not necessarily result in safety-critical situations.

In June 2016 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.

As some characteristics regarding the human machine interaction need to be clarified BASt carries out a continuative study (see 2.2.3 HMI aspects of Camera-Monitor-Systems).

2.1.4. **Urban Space: User oriented assistance systems and network management**

Together with 30 partners including automobile and electronics manufacturers, suppliers, communication technology and software companies as well as research institutes and cities BASt has joined the national project UR:BAN\(^1\) which started in 2012 running for a four-years-term until April 2016. The project has been funded by the Federal Ministry of Economic Affairs and Energy. UR:BAN focused on the development of advanced driver assistance and traffic management systems for cities and pays special attention to the human being in all aspects of mobility and traffic.

UR:BAN also covered the evaluation and prediction of vulnerable road users (pedestrians and cyclists) behavior and movements. With regard to the complexity of urban traffic UR:BAN aimed at supporting the driver in performing maneuvers such as driving in narrow or obstructed streets, resolving conflicts with opposing traffic and performing lane changes. By means of novel panoramic sensing and prediction capabilities collisions can be avoided by automatic braking and/or swerving. BASt was also involved here with legal expertise since the legal implications of the functions developed in UR:BAN needed cross-evaluation. Furthermore an experimental psychological study was carried out. The study aimed to analyze drivers’ ability to control the intervention of an emergency steering assistant in a real driving scenario. A false activation of a system-initiated steering torque overlay occurred at a time when the

\(^{1}\) www.urban-online.org
driver’s attention was distracted from the primary driving task by operating a visually and cognitively demanding secondary task. Subjective assessment showed more critical ratings of controllability under distraction than without distraction. There was no significant effect of distraction on lateral acceleration during drivers’ oversteering the malfunction of the system. However, the lane keeping performance of the drivers indicated a significantly higher lateral deflection shortly after the malfunction in case the drivers were distracted.
2.2. Ongoing research

2.2.1. 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.

At present driver assistance systems are discussed that can support the driver in the turning situation by giving a warning when cyclists are riding parallel to the truck just before or in the turning manoeuvre. 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.

The feasibility of the test procedure, taking into account available test tools and test effort, has shown that readily available test tools with slight modifications are appropriate to simulate a bicyclist travelling close to a truck. All the information (accidentology, verification test results etc.) has been brought into the UN ECE working group on general safety, and finally, the regulation development process has been started by Germany submitting a proposal as a working document for the April, 2017 session of UN ECE's GRSG.

2.2.2. PROSPECT

Several vehicles that are currently on the market feature automatic emergency braking (AEB) systems either as standard or optional fitment. Assessment procedures for these systems are under development or already available. Their expected positive effect on accident figures is taken into account in consumer testing. However, current systems suffer from a few limitations. Their intervention in critical driving situations occurs shortly before this event - at a time when the vehicle driver has almost no chance to avoid the accident by itself. As a consequence, this late reaction time makes it difficult for the AEB system to avoid (e.g. vehicle comes to a full stop just in front of the threat), in particular in high speed scenarios and scenarios with obscured pedestrians. If the braking intervention would start too early, there would be plenty of false activations in regular traffic, even in perfectly normal situations - which is not acceptable for traffic flow, from a safety perspective, and last but not least for the driver. Also, current systems only have access to vehicle braking systems. There's no automatic steering system in production (some prototypes are available).

Proactive safety systems especially for pedestrians and cyclists can be more effective, if they tune their intervention timing better to the traffic situation and driver fatigue, and if they use steering intervention additionally to braking intervention. This is where the PROSPECT (Proactive Safety for Pedestrians and Cyclists) project comes in: PROSPECT does develop advanced Human-Machine Interfaces (HMI) as well as advanced vehicle control strategies for combined steering and braking. The advanced HMI does monitor the driver's directional attention and for instance intervene earlier in cases where the threat is out of the driver's focus. The control systems make use of a tremendously increased radial sensor range to find the optimal combination of steering and braking, and advanced sensor interpretation systems allow to better judge the intention of pedestrians along the vehicle route with respect to their direction of movement.

To estimate the benefit for these new functions, advanced testing and validation methods need to be developed. Current validation of automatic brake systems is carried out on a test track, without irritating objects, road clutter, road signs or lines; thus, in rather artificial surroundings. PROSPECT does not only introduce novel realistic surrogate targets, but also performs testing in realistic surroundings including other moved objects, infrastructural facilities, clutter and the like.

Final output of PROSPECT are be three vehicle demonstrators, to be tested in detail using state-of-the art surrogate targets for pedestrians and newly developed surrogate targets for bicycles and their riders.
2.2.3. HMI aspects of 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 (see 2.1.3 Study on Camera-Monitor-Systems).

Based on the previous study 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 perceptual speed, discrimination possibilities and human’s (direct) view. On the other hand, the effect of merged presentations of backward information on human’s perception should be 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 finish end of 2018.

2.2.4. Accessibility in long distance buses

In order to deregulate passenger transport, German long-distance bus operators are now allowed to compete against one another and against rail transport. To meet the requirements of all passenger groups in the light of inclusion, their buses will have to e.g. provide two wheelchair spaces by 2020 (by 2016 for newly registered vehicles) and fulfill UNECE-R 107. These requirements build not only towards the German wide aspiration to reduce accessibility barriers, but also towards the goal to avoid barriers systematically in the future. So far, it is not clear if other specifications for equipment going beyond those accessibility requirements in long-distance buses are needed to ensure an appropriate degree of accessibility. For that purpose BASt initiated a first research project carried out by Human Factors Consult, Berlin. After having defined accessibility in this context, the main goal of the research project was to derive recommendations for measures to be taken when designing and building accessible long distance buses as a basis for international discussion on harmonised regulations. The project therefore included two subordinate tasks: first to gather stakeholder requirements and define accessibility which was both done using questionnaires and workshops and second to compose recommendations for respective measures. Different kinds and degrees of disabilities were regarded. The measures focused on the vehicle itself, the operation of the long-distance buses and on operation personnel. Road infrastructure issues were demonstrated using examples for best practice. Deriving measures took also into account the state of the art technology for barrier free access and examples coming from the rail sector. In the end also costs, feasibility (technical limits) and practicability were considered when assessing the measures proposed.

Based on the first research project a second one develops a hand book "Accessibility in long distance buses service" carried out by STUVA, Köln. This document shall act as an easily comprehensible, concise brochure with examples of "best practice" and it is intended to promote and support the implementation of accessibility in practice by the actors. The handbook does not only include accessibility measures for the vehicles required by the German law (section 42 of PBefG), but also includes infrastructure and operation. The final report serves as a basis for the preparation of the hand book. As a research report, it goes far beyond the scope of the hand book. Despite the relatively young remote bus market, there are already positive examples in the three areas of vehicles, infrastructure and operation. The developments are still at the beginning. The handbook is expected to contribute a rapid dissemination of constructive, practice-oriented solutions, thus improving the accessibility of long-distance bus services in a sustainable manner, taking into account the interests of the different actors.

2.2.5. Safety of children in cars

After the entry into force of Phase 1 of the new regulation UN R129 for child restraint systems (CRS) dealing with ISOFix Integral “Universal” CRS (“i-Size”), BASt published a brochure “Kindersicherheit im Auto” to explain the new regulation (also available for download in English “Child Safety in Cars”) and give an overview on the use of child restraint systems. This booklet was the basis for the UNECE brochure “UN Regulation No 129 – Increasing the safety of children in vehicles – For policymakers and concerned citizens”
BASt further supported the work of UNECE/GRSP Informal Group “Child Safety” dealing with Phase 2 of UN Regulation 129 to include child restraint systems for older children, boosters with backrest, into the regulation. For these CRSs, the child is secured by the vehicle belt, also a stature based system depending on the standing height of the child is used. For children up 135cm standing height the CRS can be universal, which means, that it will fit on an i-Size labeled vehicle seat. Phase 2 was agreed by WP 29 and will enter into force soon. Boosters without backrest remain in the UN Regulation 44. The UNECE/GRSP Informal Group “Child Safety” therefore developed changes for the UN R44 so that future homologations for boosters without backrest will only be allowed as group 3 CRS (from 22 kg) with a labeling that does not allow the usage below 125cm. The Informal Group “Child Safety” is now working on the third phase of UN Regulation 129 to implement integral CRSs connected to the car by using the vehicle belt system.

Euro NCAP developed a new protocol which includes the Q6 and the Q10 dummies as rear seat occupants in dynamic ODB and side impact tests. The idea behind is to improve the protection of rear seat occupants especially taller children but also small adults. In addition the CRS-car interface compatibility assessment protocol and the protocol for the vehicle based assessment were changed with regard to i-Size products to support the possibility to use CRS homologated according to the UN Regulation 129 in new vehicles.

2.2.6. Appropriate helmets for S-Pedelecs

Pedal electric bicycles have gained in importance on German streets. With the relatively new category of faster Pedelecs so-called Speed-Pedelecs or S-Pedelecs, the boundaries between bicycles and mopeds become blurred. With the legal equality between S-Pedelecs and mopeds the legal provisions for the use of helmets have to be reconsidered. While the moped is entirely powered by its engine, the engine of an S-Pedelec only assists the rider. Therefore riders of S-Pedelecs have to apply themselves physically which results in different needs regarding the weight and ventilation properties of helmets. To allow riders of S-Pedelecs to comply with the helmet laws without the constraint to use conventional motorcycle helmets, a new helmet category has to be admitted. BASt will define reasonable properties for helmets intended for the use by S-Pedelec riders. With the analysis of GIDAS accident cases and other databases, the most critical accident situations of S-Pedelec riders will be identified. The state of research regarding head injuries and possible countermeasures as well as the requirements of helmet standards other than the UNECE-R 22 and the EN 1078 will be considered. The gathered knowledge will result in requirements for helmets to adequately protect the riders of S-Pedelecs without compromising the opportunities to implement sufficient ventilation and weight reduction.

2.2.7. Active Bonnets

A Euro NCAP technical working group tasked with the update of the pedestrian test and assessment procedures finalized its activities in the year 2015. However, initiated by BASt, the topic of testing and assessment of active systems of passive vehicle safety was discussed again during the course of 2016. Deployable bonnets are expected to provide a certain clearance between the inner panel of the bonnet and the underlying structure in order to sufficiently protect pedestrians in case of a head impact during a collision with a motor vehicle. This is done within Euro NCAP by a direct comparison of the deflection of the undeployed with the deflection of the deployed bonnet on the one hand and by establishing a total clearance requirement under consideration of the package on the other hand.
In the meanwhile, a Task Force Deployable Systems under the umbrella of the UN/ECE agreement of 1998 and sponsored by the Republic of Korea has been settled. Aim is to implement legal requirements for deployable systems within GTR9 on Pedestrian safety. While the group’s overall target will include, but is not limited to ensuring the activated passive vehicle safety system being in the intended position prior to head impact of a pedestrian, BASt is furthermore aiming at the implementation of prerequisites simulating real world accident situations to ensure the system working as intended in real life, as e.g. a minimum under bonnet clearance as depicted in Figure 4.

![Figure 4: Under bonnet clearance leading to bottoming out of headform impactor in pedestrian component test](Image)

2.2.8. SENIORS

As the demographic change leads to an aging society and obesity is becoming more prevalent, the SENIORS (“Safety ENHanced Innovations for Older Road users”) project aims to improve the safe mobility of the elderly, and persons who are overweight, using an integrated approach that covers the main modes of transport as well as the specific requirements of this vulnerable road user group. BASt coordinates this research project funded by the European Commission within the Horizon2020 program (Grant Agreement No. 636136) which has started in June 2015 and aims to finish in May 2018. More information can be found on www.seniors-project.eu.

SENIORS primarily investigates and assesses the injury reduction in road traffic crashes that can be achieved through innovative and appropriate passive vehicle safety tools as well as safety systems. The goal is to reduce, in the near future, the numbers of fatally and seriously injured older road users for both major road user groups: car occupants and external road users (pedestrians, cyclists, e-bike riders). Hereby, the project covers research 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, crash and impactor tests are conducted and numerical human body model simulations are performed. BASt is deeply involved in nearly all of these technical activities.

2.2.9. Human Body Modeling

Finite-Element Human Body Models (HBMs) have considerably gained in importance as complementary tool to dummy models. The models are not only capable of representing humans of different sizes and ages. They can also be used for simulating complex accident scenarios, e.g., in impacts involving more than one vehicle or occurring under a complex loading direction, or simulating pre- and in-crash scenarios simultaneously. Furthermore, they have the potential to become method of choice when evaluating new seating or interior configurations expected for highly automated cars.

For this reason BASt is supporting the consortium THUMS User Community (TUC). TUC is a project coordinated by University of Munich (LMU) in cooperation with partners from the automotive industry. Aim of this project is to develop standardized validation and application procedures as well as agreed methods for the evaluation of crash simulation results based on a harmonized HBM version. BASt thereby considerably contributes to the development of agreed validation procedures. A substantial validation is fundamental to establish credibility in HBMs and to qualify the models to be used for the optimization of safety systems in cars. However, standardized methods for a user-independent objective validation are missing. Therefore, a validation repository is developed within the TUC project and made publicly accessible aiming to provide standardized validation protocols to the HBM community. The repository should include the simulation models of the validation environments, validation parameters in terms of response corridors and a detailed protocol of how to use the data for the application of any HBM.
Within the EU funded project SENIORS (dealing with the safety of older road users), BASt makes use of HBMs to improve vehicle safety. In one part of the project focusing on car occupant safety, BASt is working together with other project partners on a novel methodology to develop improved dummy-based thoracic criteria by paired HBM and dummy simulations.

Another part of SENIORS focuses on external road users in which an improved legform impactor with upper body mass, a head impactor with neck mass and a thorax injury prediction tool are envisaged to be developed also greatly with the support of HBM simulations. Corresponding HBM and impactor simulations were conducted against several actual vehicles and rigs, representing different frontends (Sedan, SUV, Sportscar, MPV), see Figure 5. Based on this work transfer functions and impactor prototypes will be developed.

![Figure 5: HBM and impactor simulations vs generic test rig](image)

2.2.10. EEVC Task Force TEFIRE (THOR Evaluation for Frontal Impact Regulation)

At ESV 2015 in Gothenburg, the European Enhanced Vehicle-safety Committee (EEVC) announced that it had formed a new Task Force (TEFIRE) to provide advice to the EEVC Steering Committee regarding the applicability of THOR-M in UN frontal impact crash safety legislation. Main objective of TEFIRE was to provide advice on several issues regarding the THOR-M including:

- Repeatability and reproducibility (R&R)
- Handling, durability and qualification procedures
- Seating procedures

As some of these topics were also of interest to Euro NCAP in relation to its planned introduction of the THOR dummy in 2020 the two organizations agreed to join their resources to evaluate the dummy. During the last two years BASt actively supported all activities within TEFIRE group. Based on a workshop held at BASt in October 2015, as well as other member’s experience with testing and the seating procedures, comments and recommendation regarding the THOR-M were summarized.

Significant improvements have been made to the THOR-M dummy, particularly regarding durability, which is now very good. Based on the findings of the group further improvement regarding certification requirements are needed to reduce variability between dummies. It was found that current data is based on dummies that have a range of performance in certification tests, which increases variability. This needs to be addressed in further testing.

Despite this, repeatability is considered to be Excellent or Good based on sled tests conducted by BASt and other TEFIRE members. Some remaining concerns regarding reproducibility, particularly for the thorax should be further addressed. However, evaluation of the reproducibility of the injury metrics indicated that the metrics are less variable than the individual measurements.
Figure 6: Investigation of repeatability and reproducibility of the dummy THOR-M in sled tests

2.2.11. GIDAS – new requirements to address new vehicle technology

In summer 1999, a joint effort 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 than 3,000 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 is part of an initiative, which will provide a free access, functional framework for a reliable effectiveness analysis. This will necessarily allow incorporating additional data sources and results from other evaluation methods to the GIDAS accident data: e. g. track tests or driving simulator experiments.

For future validation and verification, ex-post statistical analysis is still to be considered after a system is introduced into the mass market.

2.2.12. Estimation of the number of seriously injured road traffic casualties in Germany

Since 2015 the EC has been asking the member states of the EU to report on the number of seriously injured road traffic casualties, MAIS 3+. In Germany this number is determined by two different methodological approaches. The first approach is based on data from the German In-Depth Accident Study (GIDAS). The second approach is based on hospital data from the German TraumaRegister DGU® (TR-DGU).

GIDAS data were used in order to learn which types of accident scenarios show a rather high (or low) probability for hospitalized MAIS 3+ road traffic casualty. Applying a decision tree method 17 accident scenarios with characteristic high or low probabilities for MAIS 3+ casualties have been identified. Extrapolating the results to the National German Road Accident Statistics, a total number of 15,442 seriously injured road traffic victims (MAIS 3+) has been calculated for the year 2015. This correlates to 22.8 % of all hospitalized casualties (67,706). For 2014 a number of 15,392 MAIS 3+ victims has been computed.
The second approach, used as a plausibility check on the GIDAS based estimate, uses data from Intensive Care departments of Trauma centers and takes into account severe injuries (ISS16+) and some correction factors. This approach results in a number of 15,838 seriously injured MAIS 3+ for the year 2015, which is quite in line with the prediction based on GIDAS data.

Further investigation of the group of seriously injured MAIS 3+ casualties shall highlight specific risk groups of road users and derive countermeasures at a national and at EU level.

Figure 7: Multiple rib fracture is one of the most frequent AIS 3 injuries in road traffic, leading to seriously injured casualties

2.2.13. Heavy Goods vehicles with extended length

Unlike other European countries, Germany did not allow heavy goods vehicles longer than 18.75 m (truck-trailer) respectively 16.5 m (tractor-semitrailer). Since for some applications additional space is needed, BASi did conduct a field trial on heavy goods vehicles with extended length but without increased gross weight (the maximum vehicle combination gross weight stays at 40 tons) in the timeframe 2012 to 2016. After successfully completing this trial, four of the five different vehicle combination types have been approved for regular traffic on a set of designated roadways and if these vehicles do fulfil specific technical requirements like e.g. electronic brake system, air suspension, rear-view camera etc. Automotive engineering questions in the field trial were e.g. whether those longer trucks would require other (longer) braking distances, which was confirmed to not be the case, and whether current vehicle stability control systems are able to stabilize those vehicles in certain critical driving situations. Currently, the only remaining question is whether combinations consisting of a tractor-semitrailer and an additional centre-axle-trailer are controllable in critical situations due to their high number of articulations. This question will be answered by an extensive set of driving experiments over summer 2017.

2.2.14. 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 68km/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 weakness of the AEBS regulation is the possibility for drivers to switch those 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 weakness is that vehicle deceleration is limited during the mandatory warning phase. BASi is 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. Furthermore the possibility to resign the switch off function completely will be determined. Results are expected by late 2018, it is planned to use the results for an international discussion on UN ECE level about an adjustment of UN Regulation 131.
2.2.15. Requirements and Tests for Automatically Commanded Steering Functions (ACSF)

Except for corrective steering functions automatic steering is up to now only allowed at speeds up to 10 km/h according to UN Regulation No. 79. Progress in automotive engineering with regard to driver assistance systems and automation of driving tasks is that far that it would be technically feasible to realise automatically commanded steering functions also at higher vehicle speeds. Besides improvements in terms of comfort these automated systems are expected to contribute to road traffic safety as well. However, this safety potential will only be exhausted if automated steering systems are properly designed. Especially possible new risks due to automated steering have to be addressed and reduced to a minimum.

For these reasons work is currently ongoing on UNECE level with the aim to amend the regulation dealing with provisions concerning the approval of steering equipment. It is the aim to revise requirements for automatically commanded steering functions (ACSF) so that they can be approved also for higher speeds if certain performance requirements are fulfilled. Reasonable system specifications from an analysis of relevant driving situations with an automated steering system have to be derived to cover normal driving, sudden unexpected critical events, transition to manual driving, driver availability and manoeuvres to reach a state of minimal risk. Furthermore there is the need for the development of test procedures for automated steering to be implemented in international regulations. This holds for system functionality tests like automatic lane keeping or automatic lane change as well as for tests addressing transition situations in which the system has to hand over steering to the driver or addressing emergency situations in which the system has to react instead of the driver.

2.2.16. Research program road safety

The Federal Highway Research Institute (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).

The midterm report of the German Road Safety Program has identified as key issues the accidents of pedestrians and cyclists inside urban areas as well as accidents of cars and motorcycles on rural roads were.

Therefore BASt has compiled the clustered research program road safety (Sicherheitsforschungsprogramm, SiFo) 2016 with two focus points:

One key dimension will address road safety of bicycles in particular on inner-city roads. The second part will perform an in-depth analyze of motorcycle safety with focus of Landstraßen, rural roads.

Safety of pedestrian in urban areas will be evaluated in the 2017 research program road safety.

2.2.17. aFAS

The project „aFAS“ (Driverless Safeguarding Vehicle for Highway Shoulder Roadworks”) aims at the driverless operation of a safeguarding vehicle in order to reduce the risks for workers driving these vehicles today. The project has just delivered midterm review and put on a demonstration to take stock of its work until September 2016 at BASt. So far, the demonstration vehicle has proved capable of following the mobile roadworks automatically on testing grounds (designed to be the hard shoulder of a German motorway). The vehicle presently still requires a driver for safety-reasons. During automated operation, the speed will be limited to 10 kph (~6 mph) which is the average speed required for the performance of roadworks by the vehicle in front (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 (driverless). Both vehicles are connected via Wifi for the sake of driving-mode activation but the safeguarding vehicle relies fully on the sensor system for safety.

The development of the safety concept for driverless use on public roads is the most challenging part. It must be ensured that the automated, driverless vehicle will not leave the hard shoulder and head into the traffic passing by (most critical scenario). This key aspect is implemented by means of a sensor system able to detect the road marking reliably and by activating a second “safety path” (braking the vehicle to immediate standstill - the minimal risk or safe state). The standard ISO 26262 is being considered as guideline and reference for this work. BASt is also involved in the identification of the standards’ legal limitations.
2.2.18. Ko-HAF

In 2015 a new research project concerning cooperative, highly automated driving (Ko-HAF) has started. BAS has joined into a national consortium with automobile and electronics manufacturers, suppliers, communication technology and software companies, research institutes and road administration. The project aims at the development of cooperative, highly automated driving on motorways, i.e. for high speed ranges on well constructed road infrastructure. This includes a significant improvement of forecasts for environmental detection in addition to the automation of the longitudinal and lateral control of vehicles. The driver can not be taken entirely out of the loop during highly automated driving. Therefore, the readmission of the driving task by the human within a certain lead time will be researched in Ko-HAF as well. Several test vehicles will be constructed for testing and demonstration of highly automated driving under normal conditions and in case of system failure. The new vehicle operation will take place on test tracks and on public roads.

Key activities of BAS – in an academic part – are the definition and specification of relevant data on traffic and road conditions to be stored in the back end, the evaluation of usability of external data for the use cases of highly automated driving, the design of data exchange with third parties and the evaluation of data protection issues.

In a first practical part, BAS conducted a driving test to classify the effect of driver’s vigilance in a semi-automated 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. The effectiveness of possible countermeasures will be investigated in a second step.

2.2.19. PEGASUS

PEGASUS (project for the establishment of generally accepted quality criteria, tools and methods as well as scenarios and situations for the release of highly-automated driving functions) develops tools and procedures for the testing and homologation of automated vehicles. The 17 project partners from science and industry fields define hereby a state-of-the-art technology for the safeguarding of highly-automated driving and demonstrate the development in a practical manner, using the example application of the highway chauffeur, which takes over the highly-automated driving on the highway. With this project, key gaps in the field of testing will be
concluded at mid-year 2019, up to the release of highly-automated driving functions. 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.

BASt is an associated partner of PEGASUS and contributes to the "Evaluation of automation risks of a highly-automated driving function". The aim of the evaluation is the identification of automation risks which arise from the interaction between a highly automated vehicle and the driver. In a first field study performed on highways, factors of the traffic surrounding the automated vehicle (e. g. traffic density) are identified and their effects on the takeover capability of the driver are examined. The driving tests are intended to reveal possible safety risks during transitions and allow an initial assessment concerning the impact of the traffic situation. In a second step, an advanced application scenario will be defined and also investigated in the field. Both empirical studies use the BASt 'Wizard of Oz' vehicle which is able to simulate the considered automated driving functions.

2.2.20. CODECS

The deployment preparation of Cooperative Intelligent Transport Systems (C-ITS) involves many stakeholders, including the automotive industry, National Road Authorities and road operators (including their suppliers), automobile clubs and organisations promoting ITS as a tool to safer, smarter and more environmental friendly mobility. COoperative ITS DEployment Coordination Support is a Horizon 2020 support action (36 months, 05/2015 – 04/2018) which intends to facilitate the C-ITS deployment coordination activities on European scale (EC C-ITS Platform, Amsterdam Group). Focus areas of CODECS are coordination of initial deployment initiatives incl. profiling of standards for applications with infrastructure involvement (I2V/V2I), cross-industry alignment of deployment roadmaps and strategy coordination between core actors in C-ITS deployment. Now having reached halftime of its operation, CODECS has turned out to be a productive node in the C-ITS community. Further to regular congress participation (ITS European/World Congress, Smart City World Expo) more than ten workshops have been organised by CODECS with an average attendance of 40 experts.

2.2.21. International Cooperation

BASt holds several bilateral agreements with various governmental institutions around the world. Most of these Memoranda of understanding (MoU) are related to the research field “Vehicle engineering” and more specifically to the areas of the “Active and passive vehicle safety” as well as “In-Depth Crash investigation”. The main purpose of these co-operations is to discuss actual scientific road safety related topics with experts from the different parts of the world to strengthen common interests, to learn from each other and to reinforce harmonisation processes.

To name a few, BASt holds a MoU for motor vehicle safety research with NHTSA (United States of America) since 2010, a MoU on cooperation to advance knowledge in the field of road traffic with KOTSA (Republic of Korea) since 2010 and a MoU in the field of safety and environment of road traffic with NTSEL (Japan) since 2014. Recently, BASt has agreed on a MoU with the Chinese National Institute of Standardization (CNIS) of the People’s Republic of China in 2016. All co-operations are based on close communication and exchange of information towards the defined topics which also include bilateral meetings, joint symposia and even the exchange of research employees if found beneficial.
2.3. Perspective

As the finished studies show, vehicle safety research is an international issue. Therefore BASt participated in applying for calls of the European framework research programme “Horizon 2020”. In addition national projects complement the work addressing specific research topics. BASt was successful with regard to the projects mentioned below.

2.3.1. 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 pilots (C-Roads Austria, Belgium, Czech Republic, France, Germany, Slovenia and INTERCOR involving in addition UK and Netherlands) complement the already existing deployment initiatives of the C-ITS Corridor (NL, DE, AT), SCOOP@F and NordicWay (FI, SE, DK, NO). Together they mobilize approx. 150 Mn EUR of infrastructure investment in C-ITS services, an amount potentially to be nearly doubled from the CEF Call 2016 resulting in additional C-Roads national pilots. 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 9). 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. organizational issues, security, service harmonization, infrastructure communication, evaluation and assessment of the pilots) of the C-Roads Platform. BASt also supports the Federal Ministry of Transport and Digital Infrastructure in the Steering Committee representation.

Figure 9: Official launch of C-Roads by EU Commissioner Bulc on 12th December 2016 in Brussels ©EC.

2.3.2. 2.3.1 L3Pilot

BASt will participate in the EU project L3Pilot, which starts in 2017. The L3Pilot project aims to test and study the viability of automated driving as a safe and efficient means of transportation, explore and promote new service concepts to provide inclusive mobility. The following scientific and technological objectives are to be addressed: a) Create a standardised Europe-wide piloting environment for automated driving, b) Coordinate activities across the piloting community to acquire the required data, c) Pilot, test and evaluate automated driving functions and connected automation, and d) Innovate and promote AD for wider awareness and market introduction. BASt will contribute to a study on long-term user acceptance of automated driving and to the assessment of impacts of automated driving on road safety.

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