Executive Summary

The ActiveTest initiative has the objective to disseminate performance testing methods for ICT-based safety functions (“active safety”) in road vehicles.

Among other actions, the objective shall be fulfilled by issuing this report and road map for planning of future research topics. The report also compiles and analyses discussions from the three workshops held by ActiveTest. It points at some challenges in testing and at possible improvements of testing procedures.

This DRAFT issue of the deliverable is issued with the hope to receive comments and suggestions before issuing the final version in December 2012.
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Preface

ActiveTest is a support action within the ICT programme of the European Community’s 7th Framework Programme for Research. The general objective of ActiveTest is to increase road safety by supporting the introduction of ICT-based safety functions (“active safety”) which allow mitigation or even avoidance of accidents. These functions are necessary to reduce fatalities on European roads significantly. But there are presently no commonly accepted testing methods established.

The ActiveTest initiative has the objective to disseminate performance testing methods for ICT-based safety functions in road vehicles by:

- demonstrating performance testing of ICT-based safety functions
- disseminating the test programme developed in the eVALUE research project
- establishing an active dialogue with key stakeholder groups
- compiling an outlook for future research need
- contacting standardisation organisations for road vehicles with research results
- creating awareness of the need of standardised performance testing of ICT-based safety functions

This deliverable gives an outlook for future research needed.

The research leading to these results has received funding from the European Community’s Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 269904.

This publication solely reflects the author’s views. The European Community is not liable for any use that may be made of the information contained herein.
1 Introduction

ICT-based safety functions (“active safety”) such as Electronic Stability Control (ESC) and Lane Departure Warning (LDW) have been introduced. The purpose is to try to avoid accidents through anticipation. The largest future improvements of road safety are expected to rely on such safety functions with the aim to prevent accidents from happening. The ICT-based functions are under rapid development and there is presently, and in contrast to passive safety, no generally accepted testing procedures in place. Road safety must improve further. (Figure 1) ICT-based safety has the potential to greatly reduce the number of road accidents.

Figure 1. Road safety in the EU has improved, but needs further improvement [ec.europa.eu/transport/road_safety]

Safety measures to reduce the consequences of an accident (“passive safety”) such as safety belts and airbags have been demonstrated in performance testing by different NCAPs all over the world. Such performance testing of passive safety has greatly contributed to road safety. Performance testing methods for active safety are necessary to improve the safety performance of the new safety functions in road vehicles. Performance testing will also increase the awareness of the users that ICT-based safety functions are beneficial for all road users. Several testing methods have been presented by standardization, industry and research projects. Tools are being developed to support performance testing.
Testing is also a very important activity during the development of new active safety functions. The test tools and the test methods can often be the same as for performance testing. The major difference is that development testing requires much more efforts. The new active safety functions have to be evaluated in many traffic scenarios. Also different driver reactions have to be considered. This leads to an extensive set of test cases.

A forum is needed for exchange of experiences and to compare principles from in-house testing at manufacturers with the results of research initiatives in Europe and overseas. ActiveTest provides a forum independent from industry, and thus neutral ground to allow for informal discussions. The intention is to focus on testing methods and rating approaches, not to address if the safety level of a vehicle is “good” or “bad”. Several national and international initiatives have started for performance testing of active safety functions. They are focusing on different functionalities and levels of detail, but share the objective to enable assessment and rating of active safety systems. This report compiles and summarises some of the initiatives in this field.

It is visible today that future research work will be required over the next years. This concerns e.g. topics such as reliable and comprehensive accident statistics taking the effect of active safety equipment into account, driver models as input for repeatable and validated testing procedures using driver robots as well as methods for the determination of the safety impact given by different safety functions. All the input received through the surveys and the discussions in the three ActiveTest workshops is also compiled and analysed. It will be used for pointing out possible updates and improvements of the test procedures.
2 Initiatives for testing of active safety

There are several on-going or recently finished initiatives and research projects devoted to defining performance testing methods for longitudinal active safety systems, e.g. forward collision warning (FCW) and autonomous emergency braking (AEB) systems. To the initiatives belong ADAC [ADAC], AEB [AEB], and vFSS [vFSS]. ASSESS [ASSESS] and AsPeCSS [AsPeCSS] are two research projects which have performance testing methods for longitudinal active safety systems as parts of their scopes. Additionally, standardization organizations such as ISO and SAE has released standards for performance testing of FCW systems [ISO,SAE] and an ISO standard for AEB is under development. NHTSA has defined three test scenarios for FCW systems in their NCAP confirmation test [NHTSA NCAP].

Examples of proposed test scenarios are shown in Fig. 1. Regardless of the databases which have been used to guide the initiatives and projects, most of them end up with a similar set of scenarios. All of them have scenarios where the vehicle in front is braking, travelling at constant speed, or is stationary. Besides those some of them also specify cut-in and junction scenarios as well as scenarios with vulnerable road users such as pedestrians and motorcyclists.

![Fig. 2. Examples of car-car scenarios proposed by ASSESS (a) and ADAC (b).](image-url)
Table 1. Scenarios and parameters proposed by different initiatives

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Parameter</th>
<th>ADAC</th>
<th>AEB</th>
<th>ASSESS</th>
<th>vFSS</th>
<th>NHTSA</th>
<th>SAE</th>
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<td>30</td>
<td>40</td>
<td>50</td>
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<td>73</td>
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<td>50(^d)</td>
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</table>

\(a\): step increment until collision occurs; \(b\): at two different headways; \(c\)-\(f\): only for FCW testing; \(d\): only for AEB testing

One precondition which is not listed in the table but common in many of the test scenario specifications is the headway (time gap) which needs to be established between the TV and LV before the test sequence is initiated. As can be seen in the table there are both commonalities and differences. For example, ASSESS scenarios are the only ones covering different offsets, whereas SAE are the one considering scenarios in curves. Curved scenarios put more demands on the proving grounds since all of them have straight roads (naturally) but do not have many different radii for curves. NHTSA, SAE and some of the vFSS scenarios are only applicable for testing of FCW systems.
FCW systems are easier to test; if the required minimum time-to-collision has been passed without a warning issued, the test can be aborted. Thus a real vehicle can in principle be used as target (lead) vehicle. However, this way of testing may be a bit too simplified. First of all, in a situation where the FCW should avoid or mitigate a collision, the driver is in the loop. Therefore the HMI becomes very important: the warning modalities and their design. Also the driver reaction becomes important. An alert driver might be the difference between a collision and not. Additionally, support systems such as brake assist and well-designed brake/stability systems are not awarded.

2.1 AEB

An international group of insurer funded research centres is called RCAR (the Research Council for Automobile Repairs). Some RCAR members have formed a focus group, the so-called AEB group, with the aim of defining a set of test procedures that can be used by consumer test organisations such as Euro NCAP, IIHS and Thatcham. Thatcham is leading this group that also claims to be supported by a vehicle manufacturer and a tier 1 component supplier.

The AEB group states basing its test procedures on real crash scenarios taking into account both frequency and severity. Therefore, they use data sources that include insurance and national statistics as well as in-depth accident investigation. Test devices and tests able to represent these real world scenarios are developed by the AEB group. They publish their tests and share them with other working parties, for instance with the vFSS initiative.

Further information can be found under www.thatcham.org.

2.2 AsPeCSS

The main goal of the AsPeCSS project is to develop harmonised test and assessment procedures for forward looking integrated pedestrian safety systems that can be used for consumer rating and regulatory purposes. As such, the project is meant to stimulate widespread introduction of these systems that have high potential to improve safety of pedestrians and, in case adequate detection technology becomes available, also for pedal cyclists.

The project is an FP7 funded project, started in September 2011 with a total duration of 2.5 years. The consortium comprises Industry (car manufactures, (first tier) suppliers), research organisations and universities. The geographical representation and the balance between (end) users, research and those involved in assessing, testing and regulations ensures a European-wide approach, which is the strength of this project by means of the complementarily of the partners and their multi-disciplinary aspects. It is well known that consumer rating programmes have a strong influence on manufacturers to build vehicles that consistently achieve high ratings, thereby enforcing introduction of new safety systems that address real world needs into vehicles. Moreover, it will raise the public awareness of the benefits of these integrated safety systems by means of easy understandable rating systems.
With this goal, the objectives of AsPeCSS are:

- To develop harmonised and standardised procedures and related tools for the assessment of forward looking integrated pedestrian safety systems. Such harmonisation shall be provided at European level and will also target a broader scope worldwide. As part of this:
  - Develop a methodology for balancing direct active safety benefit, combined active-passive safety benefit, as well as direct passive safety benefit into one overall safety assessment (based on benefit estimations);
  - Develop methods and means to adapt passive safety test conditions for scenarios with preceding pre-crash action;
  - Develop test targets representing pedestrians for different sensor types.
  - To gain acceptance for future implementation of test and assessment tools in scientific, industrial, regulatory or consumer rating procedures by extensive evaluation and validation;
  - To set the bases and prepare similar activities focusing on the test and assessment of integrated protection systems dedicated to cyclists.

Further information can be found at www.aspecss-project.eu

2.3 ASSESS

The ASSESS project is funded under the Seventh Framework Programme of the European Commission and started in mid-2009 with 15 partners in total. The goal is to develop a relevant set of test and assessment methods applicable to a wide range of integrated vehicle safety systems in the longitudinal domain. More precisely, the focus is on pre-crash sensing performance and crash performance under conditions influenced by pre-crash driver and vehicle actions. This includes a study of the relevant driver behaviour as well as the development of a standardised target representing a vehicle. Additionally to the test tools for driver behaviour, pre-crash and crash evaluation, the project will deliver a methodology for the evaluation of the socio-economical benefit of active safety systems, considering the current road accident layout, the future trends and the performance level of the actual active safety systems under study.

The ASSESS project is partly based on the results of the eVALUE project with respect to the longitudinal domain. With its more focussed investigation of pre-crash functionality and related assessment, it shows an approach that can lead to the required level of detail with comprehensive protocols ready for implementation in the short term.

Further information can be found under www.assess-project.eu.
2.4 Euro NCAP

Euro NCAP has launched in 2010 its “Euro NCAP Advanced” award system for new and emerging safety technologies. It aims to provide car buyers with clear guidance about the safety benefits which these new technologies offer. The new reward system, complementing Euro NCAP’s existing star rating scheme, recognizes and rewards manufacturers who promote those new safety technologies which have a scientifically proven safety benefit. Many of the technologies are so new that no accepted standards exist to assess them. Euro NCAP has developed a methodology which allows the potential safety benefits of any new technology to be determined. Unlike Euro NCAP’s well established assessments involving physical tests at a crash laboratory, the new process is based entirely on the assessment of scientific evidence presented by the vehicle manufacturer.

In addition, for the first time Euro NCAP has tested the ESC performance of all cars crash-tested in 2009. 2009 was also the year when the ESC fitment was included as an essential part of Euro NCAP’s assessment leading to the overall award rating. Euro NCAP carried out “sine-with-dwell” tests according to the ESC Global Technical Regulation (GTR), which is based on the US regulation FMVSS126. During 2011, cars were evaluated with a pass/fail criteria based on this regulation. In the coming years, a deeper analysis will be defined. The “Beyond NCAP Assessment protocol” is available at the Euro NCAP web page www.euroncap.com.

2.5 vFSS

vFSS is a working group on Advanced Forward-Looking Safety Systems that was initiated mainly by German vehicle manufacturers and research organisations, later seeking international cooperation with other European and non-European vehicle manufacturers as well as research organisations and institutions worldwide. The aim of the working group is the development of test procedures for driver assistance systems (in particular advanced emergency braking systems) in order to ensure a robust assessment of such systems. The work is based on accident analyses and also addresses pedestrian safety issues. The ASSESS project is very much in line with the vFSS procedures on longitudinal safety systems, and the initiative is looking for harmonisation with as many initiatives as possible, e.g. CAMP-CIB and AEB.

2.6 ADAC

German motoring club ADAC, also a member of Euro NCAP, presented in 2011 results of a test series that investigated advanced emergency braking systems (AEBS). The ADAC AEBS test assessed the AEBS capability to reduce impact speed as well as when and how effectively the driver is alerted to an imminent collision in six current family and executive car models. According to ADAC, preventing a collision because of timely warning is always better than an autonomous emergency braking with unforeseeable consequences. As another important factor for enhanced driver safety, ADAC has identified system reliability. They conclude that most drivers will not accept false alarms even if they are no injury risk; unlike acci-
dental emergency braking, which may be fatal. Their test also assessed the probability of false alarms or unnecessary emergency braking. Their full test report and description of procedures is available for download under http://www.activetest.eu/pdf/adac_aebs_report_en.pdf.

2.7 CAMP

The Crash Avoidance Metrics Partnership (CAMP) was formed already in 1995 in the USA between Ford and General Motors to accelerate the implementation of crash avoidance countermeasures in passenger cars to improve traffic safety. In the meantime, other companies and institutions have joined the partnership. It is engaged in cooperative research with the National Highway Traffic Safety Administration (NHTSA) to advance the safety research objectives of the Department’s Intelligent Vehicle Initiative and also partly funded by the United States Department of Transportation (USDOT).

As a sub-project, the Crash Imminent Braking (CIB) consortium started in 2009 the investigation of “Objective Tests for Imminent Crash Automatic Braking Systems”. The purpose of the on-going project is to define minimum performance requirements and objective tests for crash imminent braking systems and to assess the harm reduction potential of various system configurations and performance capabilities. Further information can be found under www.nhtsa.gov.

2.8 Harmonisation Platforms

Because of the potential of Autonomous Emergency Braking systems in crash avoidance and injury mitigation, Euro NCAP intends to include assessment of AEBS in future protocols. Procedures will be defined by the Euro NCAP PNCAP group using information from a number of projects:

- **Advanced Forward-Looking Safety Systems (vFSS)**
  Cooperation between OEMs, research and insurance groups world-wide developing test and assessment methods for forward looking safety systems related to accidents with pedestrians and cars. vFSS also develops and applies methods and tools for prediction of system effectiveness.

- **Advanced Emergency Brake (AEB)**
  Cooperation between insurance organisations Thatcham and IIHS with support from research groups, a supplier and two OEMs. Aims and goals identical to vFSS.

- **Assessment of Integrated Vehicle Safety Systems (ASSESS)**
  EU FP7 Project consortium of OEMs, suppliers, test houses, research organisations and universities. Total 14 partners. Research on test methods for car – car accidents (no pedestrians) considering driver behavioural aspects (warning), pre-crash performance evaluation, crash performance evaluation and overall system effectiveness.
• Allgemeiner Deutscher Automobil-Club (ADAC)
  ADAC defined an evaluation method for AEBS considering the warning and autonomous braking actions, to inform consumers on the system performance. The method was applied to various systems offered to the market and reported in the media.

• Assessment methodologies for forward looking Integrated Pedestrian and further extension to Cyclists Safety Systems (AsPeCSS)
  EU FP7 Project consortium of OEMs, suppliers, test houses, research organisations and universities. Total 11 partners. Research on test methods for car to pedestrian accidents only.

In order to streamline input from the various projects to the PNCAP group, the so-called Harmonisation Platforms (HPs) have been established. The goal is to exchange information on key subjects, thereby generating a clear overview of similarities and differences on the approaches and results. These HPs are formed by different members of the previous projects. The projects run independently but via the HPs they are well informed of mutual developments. Three HPs have been established:

- HP1 Test scenarios
- HP2 Test targets
- HP3 Effectiveness analysis
3 Research agendas

Several organisations have compiled research agendas including testing "active safety", “integrated safety” or “ADAS”.

3.1 ERTRAC

The European Technology Platforms ERTRAC (European Road Transport Research Advisory Council) have developed a scenario [ERTRACscenExSum] [ERTRACscen] for road transport in 2030 and the following years. One of the conclusions is that by 2030, a harmonized policy framework for the transport sector will be needed to achieve sustainable transport in Europe in the period 2030-2050.

ERTRAC lists four major challenges:
- energy and the environment
- urban mobility
- long-distance freight transport
- road transport safety

Four likely factors contributing to road transport safety risks are mentioned. The increasing number of vulnerable road users may increase the risks. New types of vehicles will also increase the risks by accident incompatibility between vehicles. The increasing number of elderly people will put new demands for safety. An increase in the mobility demand is also likely to increase the risks.

The three main actors with regard to road transport safety are the user, the road and the vehicles. All three play significant roles for the active safety [ERTRACscen]. Active safety (or ADAS Advanced Driver Assistance Systems) is regarded to be one of the technology factors influencing road safety. Safety is expected to increase when active safety systems are more widely spread. But also society is regarded as one of the factors for road safety. Customer awareness will lead to active decisions when purchasing vehicles with safety systems.

ERTRAC concludes three crucial applications for the R&D agenda to be structured around:
- passenger and freight transport/delivery inside urban areas
- freight transport outside urban areas
- interconnections between the two transport systems

ERTRAC have also presented a strategic research agenda [ERTRACsra] [ERTRACsraExSum]. The agenda claims that a European road transport system that is 50% more efficient than today could be achieved by 2030. ERTRAC lists the guiding figures for safety as a 60% reduction in fatalities and severe injuries, and a 70% reduction in lost goods. (See figure 3.)
Deliverable D3.4

The SRA says that research is needed on ergonomically and sociologically/physiologically justified information & supporting Human Machine Interface. Also systems that support the driver to avoid or mitigate collisions need research. Modelling of the driver behaviour in critical situations and in the driving task is another research topic. Solutions to support the driver in case of impairment (distraction, drowsiness, illness) are encouraged. This can be supplemented by systems to monitor the status and the alertness of the driver.

An intelligent and adaptive infrastructure will provide an infrastructure that communicates its condition (e.g. road surface or traffic density). This information can be used as input signals to new active safety functions to warn the driver of risks and to enable a safer driving behaviour.

Figure 3. Guiding objectives for 2030 [ERTRACsra]

<table>
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<tr>
<td>Decarbonization</td>
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<tr>
<td>Energy efficiency: urban passenger transport</td>
<td>+80% (pkm/kWh) *</td>
</tr>
<tr>
<td>Energy efficiency: long-distance freight transport</td>
<td>+40% (tkm/kWh) *</td>
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<tr>
<td>Renewables in the energy pool</td>
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<td></td>
<td>Improve where possible</td>
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<td>Safety</td>
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</tr>
<tr>
<td>Fatalities and severe injuries</td>
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<td>Cargo lost to theft and damage</td>
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* Versus 2010 baseline
3.2 EUCAR

EUCAR is the European Council for Automotive R&D from major European passenger car and commercial vehicle manufacturers. EUCAR facilitates and coordinates pre-competitive research and development projects and its members participate in a wide range of collaborative European R&D programmes. The European automobile manufacturers are the largest private investors in R&D in Europe with over €26 billion investment per annum, or 5% of turnover. EUCAR members are BMW, DAF, Daimler, Fiat, Ford of Europe, GM/Opel, Jaguar Land Rover, Porsche, PSA Peugeot Citroën, Renault, Scania, Volkswagen, Volvo Cars and Volvo Group. EUCAR is closely connected to ACEA, the European Automobile Manufacturers Association. [EUCARChalPrior]

At 27th May 2011 EUCAR published a paper summarizing R&D Needs and Trends with the title 'Challenges and Priorities for Automotive R&D' [EUCARChalPrior]. In this paper EUCAR lists the following six priority themes for strategic research in the automotive sector:

- Mobility and transport in urban areas, extra-urban corridors and interfaces
- Enhanced powertrains and alternative fuels
- Electrification of the vehicle
- Safety applications in cooperative systems
- Suitable materials in automotive applications
- Ecological and efficient manufacturing of vehicles, components and systems

Within the fourth priority theme ‘Safety applications in cooperative systems’ EUCAR addresses the need for advanced in testing of active safety systems. For tackling the challenges that the European Transport Safety Council has proposed (target of reducing road deaths by at least 40% between 2010 and 2020), EUCAR and CLEPA associate to anticipate the research needs in road safety. The long-term objective is realising both efficient mobility for all societal groups within the ‘Vision Zero’ concept, which means striving for a road transport system in which no-one is killed or severely injured anymore. Considering the breakthrough in technological developments supporting new products and services, five research priorities are emphasized in a common document [EUCARChalPrior] in order to ensure the achievement of the objectives by 2020.

- **Design of vehicle safety in terms of integrated safety:** research is required to improve and widen the accident data base, identify reliable pre-crash sensing strategies and redefine secondary safety systems, develop new sensor and integration technologies and develop advanced virtual analysis and testing methods.

- **Anticipation of the safety of new vehicle concepts:** research should focuses on definition of the specific safety requirements of new vehicle concepts, redefinition of primary and secondary safety systems, development of technologies to ensure crash safety for energy storage systems, advanced methods and tools for reliable modelling, experimental and virtual testing and energy management to ensure at all times the proper functioning of critical safety systems.
• **Integration of communication vehicle-2-X in the safety design:** research is needed into in-depth accident/ incident analysis in order to better understand the pre-crash phase, low-cost technologies for sensitive and reliable real-time vehicle-2-X technology implementation, mitigation strategies including warnings, interventions and behaviour-based feedback, qualitative and quantitative situation modelling, improved IT security for drivers and vehicles.

• **Understand, modelling and improvement of driver behaviour:** accident research and naturalistic driving studies are needed to develop driver behaviour models as well as research into low-cost technologies for real-time detection of driver behaviour failures and HMI strategies for minimizing the distraction potential of in-vehicle information systems.

• **Standardisation of methodologies for evaluating new safety systems:** research is needed into advanced methods and tools for physical testing and advanced simulation tools for virtual testing, standardisation of test conditions for the tests of primary and secondary safety systems, definition of driver behaviour models for in-the-loop testing, development of field operational tests.

### 3.3 CLEPA

84 of the world's most prominent suppliers for car parts, systems and modules and 26 National trade associations and European sector associations are members of CLEPA, representing an industry with an annual turnover of 300 billion Euro, more than 3,000 companies, employing more than three million people and covering all products and services within the automotive supply chain. Founded in 1959 and based in Brussels, Belgium, CLEPA is recognized as the natural discussion partner by the European Institutions, United Nations and fellow associations (ACEA, JAMA, MEMA, etc). [CLEPA]

In 2006, CLEPA published a Strategic Research Agenda addressing the future of automotive research. [CLEPAStratResAgend] Within this agenda, CLEPA is focusing on four topics:

- Mobility
- Energy, Environment and Powertrain
- Safety, Security and Comfort
- Materials, Design, Processes and Manufacturing

In the third topic, CLEPA states that improving road safety can only be done through an integrated approach invoking all stakeholders. In terms of the vehicle, improving road safety means taking an intelligent approach, combining active and passive safety technologies and addressing every phase of driving, from normal situation driver support via preventive pre-crash actions to accident mitigation or avoidance of an accident. In order to ensure road safety in Europe, the development of safety technologies has to be accompanied by clear Europe-wide legislation focused on saving lives.
According to [EUCARChalPrior] there exists a common document from EUCAR and CLEPA, in which five research priorities are emphasized to ensure the achievement of the objectives by 2020.

### 3.4 EARPA

EARPA is an association of automotive R&D organisations, which brings together the most prominent independent R&D providers in the automotive sector throughout Europe. Its membership counts at present 39 members ranging from large and small commercial organisations to national institutes and universities. EARPA is the platform of automotive researchers and is actively contributing to the European Research Area and the future EU RTD funding programmes. For focusing on answering specific needs, EARPA is currently divided in nine Task Forces. [EARPAPosPapSaf]

In 2009, the Task Force Safety of EARPA published a position paper addressing further advanced in automotive safety with respect to importance for European road and transport research [EARPAPosPapSaf]. According to this position paper, there exist four research areas, namely areas intelligent safety, structures & materials, human aspects and assessment methods, which should be focused on in the future.

Within the fourth research area ‘assessment methods’, EARPA also addresses testing of active safety systems. Based on new research on simulation tools for integrated safety systems, a higher variety of critical traffic situations can be analysed, especially for systems acting in the immediate pre-crash and crash phase. Taking into account the characteristics of the vehicle, the user and the environment, simulation tools might enable a more exhaustive evaluation of integrated safety systems than physical tests. Research should be done on the further development of appropriate tools and on the specification of an extensive catalogue of use case scenarios, on the basis of which integrated safety systems could be evaluated virtually.

Virtual testing may even be considered a necessity to develop and validate new generations of ICT-based safety systems, as conventional test methods fall short in assessing system intelligence. The main difficulty is in the reliability of models used and the lack of statistical prediction of product variability. Virtual test models and procedures are not standardised and therefore not 100% comparable between different sources. Therefore, research should be done on model validation procedures and tools, a standardised range of biofidelic human occupant models as well as on statistical modelling strategies. As an outcome of such research, recommendations should be given regarding the implementation of virtual testing in regulation.

Furthermore, Field Operational Testing (FOT) is recognised as an effective instrument to test new transport technologies in the real world, and can help analysing and better understanding driver behaviour in driving tasks, providing information from the vehicle and from the driver both in safe and unsafe situations. More specifically, FOTs can be used to validate the effectiveness of ICT-based systems and functions for a safer, cleaner and more efficient
transport. Additionally, as a preliminary result of the running FOTs, it becomes apparent that the derivation of impacts from recorded surrogate measures from the field needs more extensive research. So far no valid methodology exists to translate changes in driver behaviour and traffic situations in impacts on safety and efficiency.

Currently, EARPA is working on an update of this position paper, which is expected to be published in October 2012.

3.5 iMobilityForum

The iMobility Forum succeeds the eSafety Forum. Its field of work includes ICT systems for resource-efficient and clean mobility in addition to the latter's focus on ICT-based safety technologies. The iMobility Forum is a joint platform open for all road stakeholders interested in ICT-based systems and services. Since its establishment in 2003, the iMobility Forum has successfully advanced on the implementation of 22 Recommendations. There is now a need to move increasingly towards deployment.

Its vision is to deliver a discussion frame for safe, smart and clean mobility with zero accidents, zero delays, no negative impact on the environment and connected and informed citizens, where products & services are affordable and seamless, privacy is respected and security is provided.

In order to work towards this vision, the Forum provides a platform for all ITS stakeholders in Europe to discuss, define, coordinate and support activities to further innovation, research, development, deployment and use of ICT based transport systems and services.

It is organized into several working groups:

- Implementation roadmap
  - Its objectives were to identify the technical and economic potential of the industry as well as the topics and timetable for infrastructure improvements by the public sector with regard to iMobility systems capable of affecting road fatalities in Europe.
  - Additionally, a comprehensive assessment was carried out to study the maturity and potential of all eSafety systems and resulted in the identifications of eleven priority systems. The Implementation Road Maps have been regularly updated and the time horizon has been extended from 2010 to 2020.

- International Cooperation
  - The ICWG will support “Inter-Continental” Co-operation, enhancing the trilateral EU-US-Japan cooperation through increased support to government-
industry cooperation of the three regions, and building on this basis extending the cooperation to a world-wide forum, involving Canada, China, India, Brazil, Russia, Australia, Korea and Taiwan;

- The ICWG will initially focus on the global harmonization and standardization of Cooperative Systems, extending the current tri-lateral work to a world-wide reach.

- **Vulnerable Road Users**
  
  - Vulnerable Road Users (VRU) are to be considered as all “non-motorised road users, such as pedestrians and cyclists, as well as motorcyclists and persons with disabilities or reduced mobility and orientation” [2012 Transport WP].
  
  - This comprises a series of heterogeneous sub-groups: Elderly (as pedestrian, cyclist, passenger, driver/rider), Child (as pedestrian, cyclist, passenger), Disabled (motor, sensorial, cognitive as pedestrian, cyclist, passenger, driver/rider), Cyclists and PTW riders.
  
  - The VRU WG aims at creating a forum encompassing all key stakeholders in the area of Vulnerable Road Users safety enhancement, and at contributing to the specific objectives and targets of the European Commission addressed within the “Horizon 2020” initiative.

- **Automation**
  
  - The group has a broad experience in different areas around the table with experience from national and EU projects like HAVEit, CityMobile, Cybercar, GCDC, SARTRE, to name just a few, but also representation of relevant organizations like EUCAR, CLEPA and EARPA. Thus a good basis for addressing the topic of automation from a wide perspective is achieved. Anyhow, depending on the outcome of the next steps it might need to strengthen the working group further by inviting relevant stakeholders from areas with so far weaker representation, including participation of relevant industry partners.
  
  - Early ideas:
    
    - To provide detailed recommendations to the EC
    - To provide a roadmap on deployment and a roadmap on technology readiness
    - To define different use scenarios to be considered during the definition of the roadmaps
- To include HMI in the context of automation (more than just a screen, it covers as well the complex aspects of driver and system interaction and driver in the loop aspects)

- To cooperate with legal issues and implementation WG

Other working groups:

- ICT for Clean and Efficient Mobility
- Digital Maps
- Business Models
- Legal Issues

3.6 ERTICO

ERTICO - ITS Europe represents the interests and expertise of around 100 Partners involved in providing Intelligent Transport Systems and Services (ITS). Its vision is to bring intelligence into mobility, working together in public private partnership towards zero accidents, zero delays, reduced impact on the environment and fully informed people, where services are affordable and seamless, privacy is respected and security is ensured.

Their activities typically focus on developing enabling technology and a common technical and business approach to Intelligent Transport Systems and Services (ITS). The implementation and market take-up of ITS are discussed in different user fora. All ERTICO initiatives are fully Partner-driven and seek to deploy ITS technologies Europe-wide and beyond in order to reap the full societal and commercial benefits.

Fields of activity are:

Safe mobility:

- Integrated road safety: provide all road users with relevant safety support from vehicle & infrastructure.
- Safe urban mobility: improve safety into the design of urban mobility services.
- Road user behaviour: enable safety innovation through better understanding of road user behaviour.

Cooperative mobility:

- Vehicle-to-Vehicle, Vehicle-to-Infrastructure communication: connect vehicles with each other and link vehicles with nearby roadside equipment and transport infrastructure.
• Cooperative monitoring: provide real-time vehicle-based data about road, traffic and environment status and incidents.

• Cooperative safety applications: provide local hazard alerts, the safe intersection, wrong-way driver warning.

• Cooperative traffic management: use vehicles as “virtual loop detectors”, provide vehicle-traffic control interaction for smooth driving.

Eco mobility
• Eco-smart driving: support drivers to adopt and then maintain a fuel-efficient driving behaviour.

• Eco-freight and logistics: enable freight routing and logistic operations to optimise fuel consumption and green goods transport.

• Eco-traffic management: implement traffic control and management systems improving global traffic network energy efficiency.

• Eco-vehicles: integrate hybrid and electrical vehicles into the transport and energy network.

Info mobility
• Traffic and traveller information, to ensure evolution from real time traffic information to truly integrated multimodal transport planning & traveller information

• Geo-localisation, to provide ubiquitous localisation through GNSS / in-door geo-positioning and appropriate location referencing methods

• Freight and Logistics, to optimise overall supply chain by means of e-freight and intermodal interoperable logistics management

• Access and Demand management, to support interoperability of European electronic toll and road charging services
3.7 EPoSS

EPoSS, The European Technology Platform on Smart Systems Integration, is an industry-driven policy initiative, defining R&D and innovation needs as well as policy requirements related to smart systems integration and integrated micro and nano systems.

In their SRA, EPoSS defines the following major R&D objectives for the next 15 years with respect to active safety:

"Driver information on vehicle dynamic limitations (e.g. traction, curve speed, ground clearance); adaptive human machine interface (HMI) systems to interact with the driver based on the specific situation; a personalised safety system adapted to characteristics of the individual (e.g. weight, age, size); driver drowsiness monitoring to sense and predict dangerous driver situations (e.g. sleep recognition); road safety in cities (i.e. at low speed); pedestrian protection systems including reacting and avoiding strategies (e.g. backover avoidance); collision mitigation systems to automatically reduce impact severity; emergency braking systems for unavoidable accidents; vision enhancement systems including night vision and blind spot monitoring, and vehicle interaction systems to allow cooperative driving using car to car and car to infrastructure communication.

Driver assistance is support to the driver in guiding the vehicle. Consumer demands, technical limits, and legal issues all require the driver to retain full responsibility for the vehicle. Taking account of the human ability to deal with complex situations, a synergetic solution aimed at extending driver abilities is the midterm perspective for vehicle control. The major R&D objectives here are:

Lateral and longitudinal vehicle guidance systems (including lane-keeping and lane-change support, ACC stop & go, and ACC for urban areas); later, semi-autonomous driving for defined situations (e.g. automated parking, automatic following and guided driving); personalised driving based on individual driving patterns, constitution, and appropriate vehicle adjustments; active load-management systems controlling chassis systems and the suspension based on the weight distribution in the vehicle; adaptive human-machine interfaces for situation specific interaction (using e.g. force feedback, head up displays, and speech recognition systems), and adaptive light projection systems for a better illumination of the vehicle’s forward scene (using, e.g., turning lights, projection, automatic high beam).

The objective is that the adaptive technical systems provide optimal driver support taking account of vehicle and driver capabilities and characteristics. EPoSS will build upon networked functionalities using numerous sensor inputs to collect information, (shared) computational power to analyse and interpret situations and decide on appropriate measures, and a variety of actuators for operations to assist the driver in a smart and situation-specific way."

EPoSS propose the following examples of smart systems:

“In terms of both Safety and convenience a first example employing the EPoSS approach will be a multifunctional smart system device based on CMOS technology integrating several
functionalities such as lane warning, pedestrian detection, and road-sign detection, while keeping the ability to detect crossing vehicles, the status of incoming traffic, tunnels, bridges, mist, fog, rain, and ambient light intensity and operates as controller of several actuators.

Networking architectures and related processing with sensors mounted at different locations around the vehicle to detect different areas in a multi-sensor and multispectral approach at both visible and infrared wavelengths could make it possible to reconstruct the road environment and obstacles, thus providing the basis for novel safety, driver assistance and convenience functions. Micro-optics with novel materials, micro-mechanics, microelectronics, advanced packaging, advanced processing (data fusion) and wireless communication links underlay such on-going developments."

3.8 European Roadmap of Electrification

The European Technology Platforms ERTRAC (European Road Transport Research Advisory Council), EPoSS (European Technology Platform on Smart Systems Integration), and SmartGrids (SmartGrids European Technology Platform for the Electricity Networks of the Future) have compiled a roadmap [ElecRoad] on the electrification of road transport.

The roadmap lists six major technology fields:
• Energy Storage Systems
• Drive Train Technologies
• Vehicle System Integration
• Grid Integration
• Integration into the Transport System
• Safety

The exploitation of active safety measures for electric vehicles are mentioned in the roadmap. Three milestones are specified and active safety is the third milestone (see figure 4). Automated driving based on active safety is envisaged for the transport system, and exploitation of active safety for electric vehicles is expected. The safety measures is one among six listed technology fields, but active safety applied for electric vehicles is still regarded as important. Plug in hybrid cars and electrical cars have to provide at least the same safety level as cars with conventional powertrains.
A dedicated roadmap was drafted for all the six major technology fields, including safety. It is estimated that research for active safety will be performed in the years 2010-2012. (See figure 5.) The ActiveTest partners estimate that active safety for electric vehicles still will be a research topic for some years after that period. The roadmap for transport system integration estimates research on autonomous driving to continue up to 2018. (See figure 6.)
Transport System Integration

Explore Potential of ITS for Energy Efficiency
Provide Convenient Transition Between Modes
Apply Sensors & C2X for Autonomous Driving
Promote Green Image of Electric Vehicles
Develop Best Practise for Implementation of Road Infrastructure Measures Supporting Rapid Uptake
Review Effects of Large Scale Deployment on Future Infrastructure Developments
EU Wide Signage of Roads and Vehicles

Figure 6. Roadmap on the traffic system integration activities
4 Future research topics for tests

A number of topics have been suggested within the ActiveTest network. Each topic is briefly described with background, objective and impact. The topics have not yet been grouped into any specific order.

4.1 Accident statistics

**Background:** The uses of accident statistics with respect to active safety systems are two-fold: analyzing accident data to find the most important accident scenarios to mitigate/avoid, and in hindsight analyze the safety impact of systems that have been introduced on the market.

Today, accident data reporting is not accurate enough. The information provided by the police or medical facilities is often brief, if available at all. Different accident scenarios are classified differently in different countries. For example a vehicle that runs off road after evading an animal could be classified either as an animal or a run off road accident.

To get better accident data, crash or event data recorders can be used. These boxes work in the same way as the black boxes in aircraft, and record the important data during the last seconds before an accident/incident.

![Figure 7: Example of the first page of the UK Police National Stats Form for accident reports](image-url)
Objective: To investigate ways of improving the quality of data in accident databases.

Impact: Accident data of better quality will give the possibility to better analyze the safety impact of specific active safety systems. Additionally, key accident-prone scenarios/situations could more easily be extracted from the data.

4.2 Driver models

Background: Driver models are gaining importance. The reason for this can partly be explained with the advent of active safety systems. Driver models are used to fine tune the systems, and to evaluate the safety impact of these systems. Additionally driver models can be used to assess macroscopic effects, e.g. traffic flow.

In future active safety and convenience systems, driver models will be important since the level of control will be shared between the driver and the system, see the figure below.

![Figure 8 Level of automation according to HAVEit](image)

Objective: The goal is to develop driver models which can be used during verification and validation of active safety functions. Driver models can be divided into strategic, tactical, and operational, where the difference is the time. Strategic is e.g. related to route choices, tactical to lane changes, and operational to steering and braking.

Impact: Driver models can be used to support design, verification, and validation of active safety systems. The models controls driving robots which mimics human driving behaviour, either in the test vehicle or other vehicles involved in the test scenario, e.g. a lead vehicle which is braking.
4.3 Harmonization of test methods

**Background:** Different active safety systems are introduced by different OEMs. The specification of these systems are similar, but never the same due to differences based on the image of the OEM, the technical solution, the price of the system and the development stage. Each OEM also develops own methods how to test and assess their own system. These methods consist of test scenarios, test tools, parameters and thresholds for certain test results.

**Objective:** The goal is to harmonize the different test methods and to introduce a common basis for all possible development solutions of one system.

**Impact:** Harmonized test methods would reduce testing costs and could be performed by independent institutions. Such methods would provide a possibility to compare different systems from different OEMs up to a certain degree. These methods would support to standardise active safety systems.

4.4 Integrated safety

**Background:** Today active and passive safety features in a vehicle are developed and tested mostly independent of each other. Integrated safety features are not taken into account as an essential part in the vehicle development process.

**Objective:** A detailed investigation on integrated safety features including positive effects on overall vehicle safety, vehicle design and overall costs.

**Impact:** A positive increase of vehicle safety will result by means of integrated safety features. Integrated safety features not only help to increase the overall safety of a vehicle, but also have positive influence on further characteristics such as vehicle weight, design and finally overall costs.
4.5 Rapid testing through use of miniature vehicles

**Background:** During the concept phase, new potential active safety systems are evaluated in driving simulators or on the test track. These are very good methods but they are not cost efficient. Rapid prototyping using scaled miniature vehicles could be an alternative.

Such a test facility requires limited computational resources even for a complex scenario with many vehicles. The tests can be performed indoors in a limited space, and thus becomes e.g. weather independent.

A scaled lab is especially useful for active safety systems based on wireless communication, in e.g. intersection or oncoming scenarios.

A challenge is to realistically mimic the vehicle dynamics and sensor capabilities in a scaled environment.

![Multi-vehicle lab of MIT](image)

**Figure 9:** Multi-vehicle lab of MIT

**Objective:** The object is to develop a scaled environment where several miniature vehicles can interact in a realistic way. Sensor performance and vehicle dynamics must be adapted to the scaled systems.

A pseudo GPS positioning system must be present in indoor facilities, and an accurate reference positioning system should be available as well to support the evaluation of experiments.

Manual control (steering, braking, etc) shall be possible to do preliminary driver behaviour studies.

**Impact:** New promising active safety systems can be evaluated without spending too much resources on expensive and time-demanding tests in driving simulators or on the test track.
4.6 Simulation for safety functions based on cooperative systems

**Background:** The active safety functions available in road vehicles today use information from sensors of the own vehicle. Yaw rate, wheel rotation, speed, steering angle and vision information are examples of information which is fed into the active safety functions. The sensors are continuously developing to allow cost-efficient monitoring of information important to the safety of the vehicle.

Road vehicles will soon be connected by wireless to other vehicles and to the infrastructure. It will be possible to receive information from other actors in the traffic environment and to act accordingly. It can be expected that the information from the traffic environment also will be used in active safety functions. One example is that the position, speed and direction of surrounding vehicles can be monitored by wireless. This is today made by vision and radar sensors combined with algorithms to identify the other vehicles.

**Objective:** Development facilities and proving grounds have to be able to simulate wireless signals from other actors in the traffic environment. It will not always be feasible to drive real target vehicles at the proving ground. The objective would be to simulate a wireless environment where the systems of the vehicle under test receives wireless signals and responds as if real physical “dummies” and target vehicles were present.

![Figure 10. Exchanging traffic information in a cooperative system](www.safespot-eu.org)

**Impact:** The simulation of a wireless traffic environment will facilitate testing of active safety functions based on wireless connections. This is necessary to demonstrate the safety of future cooperative safety functions. It will also be quicker and less expensive than actually bringing real vehicles, target vehicles and pedestrians together to reconstruct a traffic scenario.

The safety will also be increased since the risk of hitting other vehicles during the test will be dramatically reduced.
One limitation of simulating the environment by wireless connections is that a human driver will not see the other partners in the traffic scenario. It will be enough to test the active safety systems reacting on wireless inputs. But it will not be enough to put the driver in the loop as the other vehicles will be invisible to him.

4.7 Scenario development based on traffic data

**Background:** Traffic data has been collected in accident data bases. The collected information can show which traffic scenarios are most accident-prone and in best need of active safety functions to reduce the risk of accidents.

Traffic data has also been collected in field operational tests (FOTs) and researchers have drawn conclusions from experiments in driving simulators. The collected information can be used to identify traffic scenarios with a great probability of accidents occurring.

**Objective:** A positive test result in a test of an active safety function should imply that the function actually improves traffic safety. It will be important to find representative scenarios both for development testing and for performance testing.

Research based on accident data bases, field operational tests and driving simulator experiences can define the scenarios most suited for testing of active safety functions.

Figure 11. Accident investigation by the California Highway patrol [chp.ca.gov].

**Impact:** The scenarios used in active safety testing will be based on the most relevant information related to accidents. A good result at a test will indicate a high probability for a high reduction of accidents.
4.8 Target development

**Background:** There is often an unacceptably high risk to perform tests of active safety functions using real vehicles and road users in the scenario. An unexpected behaviour of the safety function under development could cause harm. This has triggered a development of "balloon cars" and other test targets which are possible to crash into with minimum danger to humans. But new sensors principles are applied and new safety functions require new ways of testing. This calls for a further development of test targets. The development can be compared to the research previously needed to find harmonized crash test dummies.

**Objective:** Test targets are needed for cars, pedestrians, two-wheelers and animals. The objective is to develop test targets which can be harmonized, and are suitable for many types of sensor systems.

A target has to be recognized by one or more of the sensor systems; radar, lidar, vision. Targets may also be perceived by the driver as a real object, when a human driver is part of the function under test. “A pedestrian target should look and behave almost like a real pedestrian.” if a true reaction from a driver is expected.

Test targets are need both as static and moving targets. For some scenarios, the target can be positioned without requirement of further movement. For other scenarios, the target will be positioned at the start position, and then operated in a controlled movement with precise speed and position. The propulsion system for a target should preferably be possible to use together with several types of targets.

Targets representing cars, pedestrians, two-wheelers and animals are needed. When novel types of small urban vehicles are introduced, also these vehicles will be needed as targets.

Figure 12. Examples of targets

**Impact:** Well-performing test targets are necessary for safe and efficient testing. A failure of a test must not lead to a dangerous situation for the test engineers. The test engineers also expect the targets to be easy to configure, run and maintain.
4.9 Testing by simulation

Background:

Objective:

Impact:

(Text under consideration.)

4.10 Vulnerable Road Users

Background: The numbers of fatalities and serious injuries in road accidents have decreased during recent years, but are still at an unreasonably high level. The number of accidents on rural roads has decreased but there are still a fair number of urban accidents. Vulnerable road users are exposed in accidents in urban traffic scenarios. The need to reduce greenhouse gas emissions may lead to increased use of “soft transport modes” (walking, bicycling etc.).

ERTRAC [ERTRACsra] have identified five parts important for the safety of vulnerable road users:

- Intelligent traffic systems for VRU safe mobility management
- Improved VRU active safety systems for accident avoidance
- Safety systems for the protection of (motor)cyclists in collisions with motor vehicles.
- Safety systems for single vehicle motor-cyclist accidents
- Mitigation of secondary impact

New active safety functions will be needed to protect both pedestrians, cyclists and motorcyclists.

Objective: Methods to test how active safety systems improve safety for vulnerable road users are needed. Test methods shall be developed for important scenarios with pedestrians and two-wheelers.

The test methods need to be based on traffic scenario regarded as representative for many of the accidents. Urban scenarios are expected to be most important. Examples are bicycles in road crossing, pedestrians at zebra crossings and motorcycles advancing in queues between cars and trucks. But also rural scenarios can be of importance. Examples are pedestrians on the road at night, and bicycles crossing country roads.
Figure 13. Pedestrians and bicycles are vulnerable in urban traffic

**Impact:** Test methods for active safety functions for vulnerable road users will support the development of efficient active safety. Proper test methods will ensure that the functions developed will lead to a reduction of accidents.

The lead time and the development cost of the active safety functions can be reduced if the performance targets are clear.

The public awareness of the benefits of active safety functions for vulnerable road users can be increased if the test results are clearly stated to explain the increase in safety.
4.11 Simulation of vulnerable road users and driver interaction

**Background:** Emergency braking systems for protection of vulnerable road users currently are in research and development. A market introduction of AEB systems for vulnerable road users is expected in the following years. In order to optimise warning and braking systems the behaviour of vulnerable road users and the interaction with the driver needs to be understood better.

**Objective:** Focus is in the investigation of VRU behaviour and especially on the driver VRU interaction. Based on this knowledge detailed models for simulation tools are to be developed, which can be used for the development and improvement of active safety systems.

**Impact:** The simulation models will support the development of efficient active safety. Proper test methods can be derived and applied in simulation. These will ensure that the functions developed will lead to a reduction of accidents.

The lead time and the development cost of the active safety functions can be reduced in simulations.

4.12 Test Procedures

**Background:**

**Objective:**

**Impact:**

(Text under consideration.)
4.13 Measuring the driver interaction

**Background:** In the operation of almost all active safety systems the driver is to some degree part of the control loop. Either the driver is expected to respond/react to some warning (optic, audio, or haptic) or should have the possibility to override the system. Therefore it is important to analyse how the average driver react in typical critical scenarios.

Additionally, to better understand human nature and develop new systems with respect to driver drowsiness and inattention, knowledge can be gathered by e.g. measuring brain activity or tracking eye movement and blink duration/frequency.

**Objective:** A specific goal is to find out how drivers interact with active safety system, and more generally how drivers act and behave during driving, with respect to e.g. fatigue and attention/distraction.

![Image of measuring brain activity of driver](image)

Figure 14. Measuring the brain activity of the driver [Nissan]

**Impact:** The collected information can be used to device new or better active safety systems which potentially could reduce the number and consequences of road accidents.
4.14 Scenario development based on naturalistic driving data

**Background:** Today development and testing of safety systems is mainly based on accident data. For accident data development of different data bases has started some years ago. There are intentions to generate detailed data bases on European level or in-depth data bases such as the German GIDAS data base.

The disadvantage of accident data bases is that only cases are considered in which an accident happens. It is quite difficult to reconstruct accidents and find the root cause for an accident to happen. Especially accidents which are caused by the driver cannot by analysed in as much detail as necessary.

Naturalistic driver behaviour needs to be understood in order to reduce accidents caused by the driver and develop the necessary safety system.

**Objective:** The goal is to create a database of critical scenarios by means of naturalistic driving data. This data base would include not only accidents, but also critical situations, which can lead to accidents due to driver errors such as driver distraction.

**Impact:** The data base will support the development of new active safety systems and increase active vehicle safety in critical driving situations. The systems will detect the driver's behaviour and act appropriate in order to mitigate or avoid critical situations which have the potential to lead to accidents.
4.15 System safety analysis

Background: Coupled functions and complex traffic scenarios require thorough understanding of the risks associated to them. One example would be when future autonomous driving vehicles are mixed with manually driven vehicles and pedestrians in urban environments. The traffic scenario will then be quite complex. It will not be a trivial task to identify the all hazards and to estimate the risks. A hazard and risk analysis should identify all hazardous situations, evaluate the risks and analyze how different safety functions can influence each other. Test procedures and test cases have to be developed to cover all potential hazards.

The system safety will be depending on proper handling of all hazards associated with the scenario. Driver actions, vehicle functions, failure of a vehicle, failure of the infrastructure, weather conditions, traffic density and other factors need to be judged.

Objective: The goal is to develop a method to identify hazards and estimate risks for complex traffic systems and thereby understanding the need for new active safety functions. Principles for reducing the unacceptable risks should be proposed. Methodology used for development of functional safety in electronic systems in road vehicles may be applied for the traffic system.

Figure 15. Hazardous situations in complex traffic scenarios can be difficult to comprehend

Impact: The methods for system safety analysis will support the understanding of complex traffic systems and help the introduction of novel active safety systems.
4.16 Accident Avoidance by steering

Background:

Objective:

Impact:

(Text under consideration.)

4.17 Torque vectoring techniques

Background:

Objective:

Impact:

(Text under consideration.)

4.18 ... more topics ...

Background:

Objective:

Impact:

(Text under consideration.)
5 Discussions at ActiveTest workshops

5.1 Workshop 1

(Text under consideration.)

5.2 Workshop 2

(Text under consideration.)

5.3 Workshop 3

(Text under consideration To be added after workshop 3.)
6 Conclusions

(Text under consideration)
7 References

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Annex A. Standards and Regulations

Within the International Organization for Standardization (ISO) there are two technical committees (TCs) with activities related to active safety systems. In TC 22 - Road Vehicles, there is a subcommittee (SC 9) responsible for standards related to vehicle dynamics and road-holding ability. Examples are standards for braking as well as lateral, yaw and roll stability. The second relevant committee is TC 204 in which one working group (WG 14) is working with standards related to vehicle/roadway warning and control systems. Examples are standards for FCW, ACC and LDW systems.

SAE International also has some committees working on standards related to active safety systems. The most relevant committee is the Safety and Human Factors steering committee within the Vehicle Safety Systems group. Other relevant SAE groups and committees are: Safety Systems Component Advisory group, Truck and Bus Brake Systems committee and Highway Time Forum Steering committee.

The National Highway Traffic Safety Administration (NHTSA) in the US has proposed three test procedures for FCW, LDW and ESC systems which are related to US NCAP (New Car Assessment Programme) assessments. Euro NCAP has a specific test protocol for ESC systems, and other active safety systems can be rewarded (Euro NCAP Advanced) by using the Beyond Euro NCAP Assessment Protocol. ESC systems are rewarded if fitted in the assessed vehicle in the Australasian NCAP (ANCAP). Other NCAP organizations are: Japan NCAP (JNCAP), China NCAP (C-NCAP) and Korea NCAP (KNCAP).

ISO 3888-1:1999 Passenger cars -- Test track for a severe lane-change manoeuvre -- Part 1: Double lane-change

ISO 3888-2:2002 Passenger cars -- Test track for a severe lane-change manoeuvre -- Part 2: Obstacle avoidance


ISO 6597:2005 Road vehicles -- Hydraulic braking systems, including those with electronic control functions, for motor vehicles -- Test procedures

ISO 7401:2003 Road vehicles -- Lateral transient response test methods -- Open-loop test methods

ISO 7975:2006 Passenger cars -- Braking in a turn -- Open-loop test method

ISO/TR 8725:1988 Road vehicles -- Transient open-loop response test method with one period of sinusoidal input
ISO/TR 8726:1988 Road vehicles -- Transient open-loop response test method with pseudo-random steering input

ISO 9815:2010 Road vehicles -- Passenger-car and trailer combinations -- Lateral stability test

ISO 9816:2006 Passenger cars -- Power-off reaction of a vehicle in a turn -- Open-loop test method

ISO 11012:2009 Heavy commercial vehicles and buses -- Open-loop test methods for the quantification of on-centre handling -- Weave test and transition test

ISO 11026:2010 Heavy commercial vehicles and buses -- Test method for roll stability -- Closing-curve test

ISO 12021:2010 Road vehicles -- Sensitivity to lateral wind -- Open-loop test method using wind generator input

ISO 13674-1:2010 Road vehicles -- Test method for the quantification of on-centre handling - Part 1: Weave test

ISO 13674-2:2006 Road vehicles -- Test method for the quantification of on-centre handling - Part 2: Transition test


ISO 14791:2000 Road vehicles -- Heavy commercial vehicle combinations and articulated buses -- Lateral stability test methods

ISO 14792:2003 Road vehicles -- Heavy commercial vehicles and buses -- Steady-state circular tests

ISO 14793:2011 Road vehicles -- Heavy commercial vehicles and buses -- Lateral transient response test methods

ISO 14794:2011 Heavy commercial vehicles and buses -- Braking in a turn -- Open-loop test methods

ISO 15037-1:2006 Road vehicles -- Vehicle dynamics test methods -- Part 1: General conditions for passenger cars


ISO 16234:2006 Heavy commercial vehicles and buses -- Straight-ahead braking on surfaces with split coefficient of friction -- Open-loop test method
ISO 16333:2011 Heavy commercial vehicles and buses -- Steady-state rollover threshold -- Tilt-table test method

ISO/AWI 16552 Heavy commercial vehicles and buses -- Stopping distance in straight-line braking with ABS -- Open loop and closed loop test methods


ISO/TS 20119:2002 Road vehicles -- Test method for the quantification of on-centre handling -- Determination of dispersion metrics for straight-line driving

ISO 21994:2007 Passenger cars -- Stopping distance at straight-line braking with ABS -- Open-loop test method

ISO/AWI 11270 Lane keeping assist systems

ISO 15622:2010 Intelligent transport systems -- Adaptive Cruise Control systems -- Performance requirements and test procedures

ISO 15623:2002 Transport information and control systems -- Forward vehicle collision warning systems -- Performance requirements and test procedures

ISO 17361:2007 Intelligent transport systems -- Lane departure warning systems -- Performance requirements and test procedures

ISO 17386:2010 Transport information and control systems -- Manoeuvring Aids for Low Speed Operation (MALSO) -- Performance requirements and test procedures

ISO 17387:2008 Intelligent transport systems -- Lane change decision aid systems (LCDAS) -- Performance requirements and test procedures

ISO 22178:2009 Intelligent transport systems -- Low speed following (LSF) systems -- Performance requirements and test procedures

ISO 22179:2009 Intelligent transport systems -- Full speed range adaptive cruise control (FSRA) systems -- Performance requirements and test procedures

ISO/AWI 22839 Intelligent Transport System -- Forward Vehicle Collision Mitigation Systems - Operation, Performance, and Verification Requirements

ISO 22840:2010 Intelligent transport systems -- Devices to aid reverse manoeuvres -- Extended-range backing aid systems (ERBA)
ISO/NP TR 26682 Crash and Emergency Notification Reference Architecture

ISO/NP 26684 Cooperative Intersection Signal Information and Violation Warning Systems (CISIVWS)

J2399_200312 Adaptive Cruise Control (Acc) Operating Characteristics and User Interface

J2400_200308 Human Factors in Forward Collision Warning Systems: Operating Characteristics and User Interface Requirements

J2478 (WIP) Proximity Type Lane Change Collision Avoidance

J2536_200401 Anti-Lock Brake System (ABS) Road Test Evaluation Procedure for Trucks, Truck-Tractors and Buses

J2802_201001 Blind Spot Monitoring System (BSMS): Operating Characteristics and User Interface

J2808_200708 Road/Lane Departure Warning Systems: Information for the Human Interface

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J2909_201005 Light Vehicle Dry Stopping Distance

J2926 (WIP) Rollover Test Methods


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Euro NCAP ESC Test Protocol

Beyond NCAP Assessment Protocol